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## Research Papers

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**Research Paper**

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## **Curriculum Design of and Rationale in *Managing Agroecosystems* — A Core Subject in the Sustainable-Agriculture Postgraduate Coursework Programme in Australia**

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In sustainable agricultural-management education, agricultural ecology enables the postgraduate learner to practice holistic and sustainable agriculture in real life. In recent decades agricultural education has evolved necessitating learners to demonstrate high levels of intellectual capabilities and logistical skills in the ecological management of agriculture. To meet such a need, we developed *Managing Agroecosystems* at the Orange campus of Charles Sturt University (CSU–O). In this paper we describe the design and rationale in teaching this subject, which sits within a coursework programme in sustainable agriculture. *Managing Agroecosystems* operates with other subjects that collectively represent and reinforce the *Triple Bottom Line* (TBL) concept of sustainable development. The Sustainable Agriculture Programme (SAP) at CSU–O has been constructed on the TBL concept. Curriculum of *Managing Agroecosystems* has been designed to empower the learner to (i) make sense of historical agricultural practice, (ii) apply that learning in issues of contemporary agricultural practice, (iii) recognize and validate those practices that favour sustainability, and (iv) determine those that have not. Teaching strategy of *Managing Agroecosystems* emphasizes self-directed learning by engaging the learner in a contemporary research challenge: the learner chooses an appropriate local problem and deals with it. To achieve alignment between learning activities and outcomes, we have designed *Managing Agroecosystems* facilitating learners to explore patterns of ecological processes in natural environments and apply that exploration in agricultural contexts. Learners are trained to hone their already acquired research skills by applying systems principles in the evaluation of diverse management options; they learn to infer impacts of systems principles in terms of performance, productivity, stability, social equity, economics, and sustainable management of natural resources. To achieve the most desirable outcomes such as free and motivated learning, self-directed learning reinforced in *Managing Agroecosystems* fosters capabilities to think, differentiate, and rationalize. Learners practice how to handle and solve unfamiliar problems in unfamiliar contexts. *Managing Agroecosystems*, seated at the intersection of ecology, agriculture, and management, has been developing employable and intellectually flexible graduates with the capability to develop new solutions to problems, as evidenced in learner feedback.

**Keywords:** *agricultural-management education, capability building, constructive alignment, ecological management, research skills.*

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### The context

Practitioners of sustainable development achieve proficiency by applying new thinking to deal with problems and innovative approaches to solve them. Such thinking and approaches need to remain in congruence with the 'triple-bottom line' (TBL) concept (see Hamblin, 2001), which integrates the ecological, social and economic dimensions of sustainable development. To achieve the congruence, formal professional education in sustainable development has to draw from holism (Carley and Christie, 2000; Stables and Scott, 2002) and systemic thinking (Ikerd, 1993; Seiffert and Loch, 2004; Martin, 2008). In the specific context of sustainable agricultural-management education constructed on TBL concept, learning about ecologically managed agriculture provides the theoretical and practical basis for the postgraduate learner to be able to design sustainable agricultural systems and launch them effectively in their future professional lives. Consequently, in educational planning, empowerment of learners with greater levels of intellectual capabilities and practical skills in the ecological management of agriculture and their landscapes has gained ground. In such a context, in this paper, we describe and discuss the design and presentation of an agricultural-ecological management subject offered through distance mode under the title *Managing Agroecosystems*. This is one subject in a multi-subject postgraduate coursework programme in sustainable agriculture in Australia.

In this paper, we describe the educational approaches that reinforce a learning practice constructed on holism and systemic thinking. We demonstrate that the disciplinary strengths of agricultural ecology integrate with the techniques used by us in encouraging self-directed (Brockett and Hiemstra, 1991) and capability-based (Stephenson, 1998) learning. We also

demonstrate that the practice followed in teaching *Managing Agroecosystems* is in accordance with Biggs's (1996) pedagogical principle of constructive alignment, which proposes a matching of learning objectives, teaching and assessment.

### Sustainable-Agriculture Programme at Charles Sturt University

The sustainable-agriculture programme (incorporating an articulated postgraduate certificate, diploma, Masters) at the Orange campus of Charles Sturt University (CSU-O) has evolved in stages involving phased improvements in the overall structure and design, since its inception in the late 1990s. This section provides a summary of the overall context of the programme, outlining its conceptual underpinnings and development over time, thus delineating the specific context of *Managing Agroecosystems*.

Thoughts on starting the sustainable agriculture programme (SAP) (Eiseman *et al.*, 1991) were influenced by the concept of sustainable development as indicated in the Brundtland Report (World Commission on Environment and Development, 1987), enriched further in the Australian policy documents, the *National Strategy for Ecologically Sustainable Development* (Ecologically Sustainable Development Steering Committee, Government of Australia, 1992) and the *Sustainable Agriculture Assessment Report of the Commonwealth Standing Committee on Agriculture and Resource Management* (1998). SAP acknowledges agriculture as a systematized human activity that involves the modification and management of terrestrial and aquatic ecosystems to service the needs of human society. Throughout this paper the term *agroecosystem* would mean either the land used for raising crops, pasture, and livestock, or water used for raising aquatic organisms, both set within the

larger landscape (also referred as *catchment* and *watershed*), which supports other plants and animals. The core principle of SAP is that sustainable-agricultural systems are to remain socially acceptable and economically viable, and also to enhance the natural-resource base and functional vibrancy of ecosystems.

The curricular aims of SAP were determined as follows:

That the graduates would be enabled to

- think creatively and critically about systems of agricultural production and land management so as to enhance levels of sustainability at a range of scales
- develop economically sound, socially viable and ecologically sustainable agricultural production systems
- strengthen their skills in effective communication, anticipative planning, sharp inquiry sense, and problem solving, hence to be leaders in sustainable agriculture
- understand scientifically sound and cost-effective pathways towards sustainable management in Australia, and apply that understanding through small-scale self-directed learning exploring contemporary issues of Australian agriculture and its sustainable management.

An additional, but key, curricular aim was self-development of graduates as thinking and empowered individuals, who would demonstrate the capacities to

- develop their personal philosophy of sustainable agriculture
- collaborate in learning and undertake cooperative research-based investigations with farmers and other stakeholders
- integrate ecologically-sustainable agricultural production systems with business management, self-management, and social behaviour
- apply their learning to real-world situations

and issues

- adopt the habit of continuous learning after the completion of formal study.

In its original design made in the 1990s, SAP included (i) *Sustainable Agriculture: Issues & Viewpoints*, (ii) *Managing Agroecosystems*, (iii) *Research Methods*, and (iv) *Sustainable Agriculture Dissertation* as the core subjects. The electives were grouped under the streams (specific titles of subjects are indicated in italics in brackets) (i) Agricultural Systems (*Integrated Pest Management, Alternative Agriculture*), (ii) People (*Strategic Management in Agriculture, Managing Change*), (iii) Business (*Agricultural Risk Management, Foundations of Marketing*), and (iv) Natural Resources (*Sustainable Soil Management, Property and Catchment Planning*). In subsequent years, SAP underwent a series of professional reviews and modifications that reflected changes within the University as well as the in the global paradigms on agricultural sustainability (Sydorovych and Wossink, 2008). Despite multiple changes over the years, the TBL concept continues to direct SAP and offering of *Managing Agroecosystems* continues to occupy a central role.

In the following section we explain the curriculum design of *Managing Agroecosystems*. First, however, we present a brief description of logistical details of the programme.

Graduates with a bachelor's degree in agriculture, natural-resource management, environmental science, and biology usually form the bulk of the enrollees in the SAP. Rarely, however, applicants without a bachelor's degree, but with proven work experience in an agricultural enterprise, are admitted into the programme. Applicants of the latter category, before being offered admission, will be carefully verified for their academic capacity and aptitude to take on the rigour involved in a senior-level study pro-

gramme.

Learners completing certificate and diploma programmes generally end up as assistant managers and project officers in diverse agricultural and related enterprises, from privately owned crop and horticultural farms to state-administered agricultural departments and private agriculture-based industries. Learners completing the master programme usually get into middle—senior management level jobs either in academia or in government research departments and private agricultural research institutes.

Sustainable Agriculture Programme has been regularly reviewed since its inception, and most recently in 2009—2010. Past reviews have recommended the continuation of the programme with endorsement from employers of graduates. As a result the programme has remained essentially the same, but with minor changes and periodical updating of the contents. The 2009—2010 review sought inputs from current students, graduates, and representatives of agricultural-apex bodies and potential employers. Specific changes to the course curriculum were implemented following the review, the most vital of them being the addition of two new core subjects, covering aspects of resource — environmental economics and human ecology. Graduates and employers have provided evidences in writing for the success of graduates in contributing to sustainability in diverse fields of agricultural sector, both public and private. However there has been no ‘before and after’ assessment of learner competencies.

### ***Managing Agroecosystems: Curriculum Design***

The objectives of *Managing Agroecosystems* are to empower the learner to

- think, reflect, and learn useful messages from

historical agricultural practice

- apply that learning to solve issues in contemporary agricultural practice
- recognize and validate those practices that have favoured sustainability over time and be able to identify those that have not.

Because the subject seeks empowering learners with a strong analytical ability, the curriculum has been so designed that the learners would demonstrate the capabilities to

- analyze ecological principles that drive agriculture and apply them meaningfully in relevant contexts
- evaluate sustainability within contexts of ecological disturbance and recovery
- discuss sustainable agriculture in the context of global food security
- critically assess the outcomes of research and development projects that involve sustainable farming practice
- develop eco-friendly agricultural system models to preserve agricultural and ecological resources and gauge the soundness of such models
- display management skills in generating sustainable, eco-friendly technologies in crop ecosystems, through a small-scale research activity.

*Managing Agroecosystems* is a 1-semester offering to all learners enrolled in SAP irrespective of the stream the learner chooses to specialize. Because a sound knowledge of basic ecological theory is not a prerequisite for enrolment in the SAP, the design of *Managing Agroecosystems* has been made recognizing keeping that element. *Managing Agroecosystems* is offered through three modules: (i) Ecological principles relevant to agriculture, (ii) Ecological processes in agroecosystems: concept of sustainability in agriculture, and (iii) Efficient management of sustainability: towards eco-friendly agricultural

systems, and is spread over a 16-week functional semester. These three modules provide the framework for the three assessment tasks (assignments) outlined in subsequent sections.

Teaching strategy of *Managing Agroecosystems* emphasizes self-directed learning, which is facilitated by a printed study guide. This study guide includes an outline structure of the semester-long learning programme, details of the recommended study topics, copies of essential readings, and a supplementary list of suggested additional readings, which will include a selection of recent research articles and selected chapters from most-recent books. In learning *Managing Agroecosystems*, learners use the resources identified in the study guide, the subject's website as well as personal observations, and media-based experiences. Learners discuss with the subject coordinator and their peers online. Learners are strongly encouraged to interact with professionals in related fields (e.g., extension officers, scientists, social scientists employed in departments of agriculture and other government departments). Out of these stimuli the learners negotiate the depth and breadth of their engagement in their assessment tasks.

### ***Dedicated research-based assignments reinforcing self-directed learning***

The design of the assignment tasks is such that it necessitates demonstration of the learner's self-directed study by completing a small-scale, hands-on research task on a contemporary real-life issue that would involve field work. From where do learners get the theoretical knowledge

and skills training that are required for conducting the research project? As a general rule Australian undergraduate programmes include training in qualitative and quantitative research methods, conducting a small-scale research project, and writing a professionally acceptable report. For example, the 6-semester long undergraduate programme, *Bachelor of Ecological Agricultural Systems* offered in CSU-O includes the subjects *Research Methods & Statistics* (Semester 5) and *Research Project* (Semester 6), each one of one semester duration, each one providing training in research theory and practice. The study guide supplied to learners in advance includes guidelines, which facilitate learners in selecting a project that will enable them to achieve the objective of self-directed learning.

The following paragraphs explain the mechanics of the assessment.

The major assignment task requires the learners to complete a research-based learning contract\*, which is weighted at 70% of the total. For reasons of convenience, this major assignment task is divided into Assignment 1 (the learning contract proposal; final assessment value 0%) and Assignment 3 (the executed research-study report) (final assessment value 70%). (A learning contract is an agreement between an individual student or group and the subject coordinator on aspects of what will be assessed.) Learners submit assignments 1 and 3, one after the other in a specified timeframe, which are reviewed and assessed independent of one another. In the time between submitting Assignments 1 and 3, learners submit Assign-

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\* A learning contract is a learning-design element that allows the learners to channel their learning according to their needs and interests. A learner submits a proposal explaining a mini-research task (the project) following the guidelines and the project is approved, either with or without negotiation, by the teacher responsible. The project culminates in the submission of a major assessable work. A learning contract will normally specify the criteria against which it may be assessed. Because projects can vary in focus, assessment criteria tend to be general rather than specific.

ment 2 (final assessment value 30%), which requires providing a detailed analytical response to an identified theme by providing an ecological discourse, and thus demonstrating their versatility in general ecological theory and practice.

#### *Assignment 1*

To meet the requirements of Assignment 1, learners submit a 700–800 word proposal, in three weeks of commencement of classes, identifying a topic — worthy of researching and achievable within the semester timeframe — that would broadly fall within the context of *Managing Agroecosystems*, considering the following:

- an issue that can be remedied by agroecological methods relevant to the region/locality of the learner
- an evaluation of the historical context of the issue
- a justification why the chosen issue is contemporary and needs resolution
- an experiment/field trial (so that it can be completed in approximately 14 weeks, within a functional-semester timeframe of 16 weeks) that will achieve a convincing resolution anticipated outcomes and management strategies.

In the submitted assignment, learners are urged to provide the following details in a professional-report format following a standard style (e.g., *Cambridge Manual for Scientific Style and Format*, The Council of Science Editors 2006) conforming to the word limits stipulated: (i) a tentative title, (ii) a brief statement of the issue to be investigated (the *Research Problem*) (100 words), (iii) justification for the choice of the research problem and which learning objectives of the subject will be met through this investigation (100 words), (iv) the mechanism and strategies that will be adopted by the learner to achieve the identified learning objec-

tives (200 words), (v) a brief description of the methods to be used in the investigation (200 words), (vi) mechanism of demonstration of achievement of learning (150 words), (vii) a time chart earmarking the action plan, and (viii) list of references matching those cited in the text.

The submitted assignment would be assessed as either ‘satisfactory’ or ‘unsatisfactory’. Irrespective of the status achieved a detailed, word-processed feedback would be provided to the learner within 2–3 days of assignment submission. The feedback would include critical references to (1) the technical soundness of the choice of the issue to be investigated, its relevance to *Managing Agroecosystems*, its relevance to local agricultural — natural-resource management context, and its usefulness and pertinence to related national and global contexts, (2) description of the measurement tactics (learners can opt to follow either a quantitative or a qualitative approach; if they decide to do an experimental trial using a quantitative approach, then they would explain the sampling strategies, adequacy of sample sizes for testing, statistical testing tools to be used, and achievability of the research task within the functional semester frame; on the other hand, if they decide to do a sociological study using a qualitative approach, then they would explain the sampling strategies, details of survey questions, population size, and the way the generated data would be processed and interpreted).

A learner achieving an unsatisfactory level would be encouraged to revise the submitted assignment and resubmit in the following three weeks and the earlier described process of assessment is repeated.

#### *Assignment 2*

Learners would present a discourse (not exceeding 5000 words and including a profession-

ally presented bibliography) by responding to one of the themes identified (A–D) below:

- A. “Energy can neither be cycled nor reused – matter can”. Critically evaluate this assertion and its significance in the function of a natural ecosystem and in an agro ecosystem.
- B. “Much of the world’s forests have been cut down for timber or to open up land for agriculture.” Discuss the consequences for the communities that live in rivers and the human communities that live on the floodplains.
- C. Taking an environmental pest that has been introduced into your region; evaluate various consequences to the natural environment of your region.
- D. A.G. Tansley, the ecologist of the early 20th century, when asked what he meant by nature conservation, defined it as maintaining the world in the state he knew as a child. From your perspective, as we are in the 21st century, how would you define and explain the aims and scope of conservation biology?

In discussing the selected topic, the learner is expected to demonstrate the use of the study material and the list of references cited therein and the learner’s independent search for relevant new information.

The assessment criteria include a comprehensive review of pertinent literature, demonstration of the learner’s ability to analyze relevant ecological principles and concepts, and, synthesis of ecological knowledge in the management processes.

### *Assignment 3*

Based on the review of and feedback on Assignment 1, learners conduct their experimental study, submit a written report, in high professional quality, before the end of the semester.

The items to be included are

- A cover page with the title, learner details, and a 150–200 word abstract, which will include brief details on the proposed investigation by identifying the purpose of the investigation, research question (or the hypothesis), results obtained, and a concluding statement outlining whether the research question has been alluded to in positive or in the negative.
- An introduction (of 600–750 words), which will state the issue investigated, justification as to why that issue was critical to the locality (or region), and concluding with the specific research questions that have been addressed. In the context of addressing the justification as to why the chosen issue was critical, the learner is expected to comprehensively review pertinent literature in a succinct manner.
- A section on materials and methods used (500–600 words) will follow the introduction. The learner will also include a brief note on the methods employed to analyze the collected data. The learner at this stage could follow a quantitative approach involving empirical sampling procedures and analyze his/her data statistically, with a reliable sample size. Alternatively, the learner could choose to follow a qualitative approach identifying the nature of stakeholders who may have a stake in the identified issue for the investigation and considering their opinions through a structured questionnaire.
- A section of results (800–1000 words).
- A section on discussion incorporating an analysis of the results obtained in the context of ecological knowledge and agricultural management processes (1000–1500 words).

Elements of originality and creativity would be considered favourably, while assessing the report. Table 1 provides a representative list of titles of research assignments that were successfully completed in 2009. These titles

**Table 1. Research assignments successfully completed in *Managing Agroecosystems* in 2009\***

1. *Trial of two non-chemical management measures for red-legged earth mite (RLEM): sustainable options for managing RLEM in pasture in south-western Victoria* by Mark Lee [A quantitative study of biological control of an arthropod pest infesting pastures].
2. *The relationship between tree and leaf characteristics with soil acidity in eucalyptus woodlots* by James Donnelly [A quantitatively correlated measurement of the implications of one non-preferred soil feature on tree performance].
3. *Shelterbelts and their influence on soil moisture* by Barbara Chenoweth [A quantitative measurement of enhanced biological diversity in agroecosystems *via* agroforestry and its impact on one preferred soil feature].
4. *Influence of native grass hedgerows and borders on radish yield and soil pH* by Christopher Radcliffe [A quantitative measurement of enhanced biological diversity in a selected vegetable crop ecosystem and its impact on one preferred soil feature].
5. *Vegetative matter content in soil and its effect on moisture retention in a semi-arid environment* by Blaise Flanagan [A quantitative measurement of soil organic matter and its relevance in soil-water retention in dry soils].
6. *The impacts of development in the metro-Atlanta region of Georgia: the role of sustainable agricultural practices and implications for food production and security* by Simon Underhill [A qualitative study of perceptions of sustainable agricultural practice and production systems among the residents in a suburban environment].
7. *The role of farmers' markets in the community: an evaluation of farmers' markets and their contribution towards a sustainable food supply system* by Fiona Wyborn [A qualitative study on the relevance and usefulness of supply chains and direct marketing of locally produced fresh food products by small-scale farmers].

Titles (italicized) listed here are representative. The learners, Mark Lee, James Donnelly, Christopher Radcliffe, Blaise Flanagan, Simon Underhill, Fiona Wyborn, gave permission in writing to publish their research assignment titles. Nature of the study has been briefly explained in square brackets after each title.

indicate the context, breadth, and depth of the field-based multi-disciplinary research undertaken by this group of learners.

### Learner Feedback

Approximately 120 distance-education learners from Australia, two from the US, one from Argentina, and one from UK, have completed *Managing Agroecosystems* as of 2009 and as part of their enrolment in SAP. Learner experience and their enthusiasm about this subject are reflected in the following samples of feedback (names withheld) obtained over several

years of offering of this subject.

“The subject was highly useful and enabled me to think differently in managing the properties I own”; “studying *Managing agroecosystems* was a unique experience that enabled me to link ecological knowledge with commercial agriculture”; “investigating a conventionally managed farm for several decades and providing an ecologically sound management plan was an exciting learning experience”; “I am profoundly equipped with rational thinking and research approach to tackle agricultural issues

and scientifically sound ecological management”; “*Managing agroecosystems* is a special subject that provided useful training in dealing with real-life issues and has enabled me to think intensively and act extensively”; “the research experience was fantastic”.

### **Constructive Alignment of and Capability Building in *Managing Agroecosystems***

Constructive alignment, a highly useful concept in higher-education pedagogy, emphasizes that learners be empowered in a manner that they can construct new meanings from what they do to achieve best learning outcomes, whereas the teachers would be able to align the activities intended for learning with the outcomes expected at the conclusion of learning (Biggs and Collis, 1982; Biggs, 1996). The premise of constructive alignment is that the curriculum should be so designed that the learning activities and assessment tasks remain positively lined up with the intended learning outcomes, establishing contiguity and consistency. In keeping with these dictates of the principle of constructive-alignment, *Managing Agroecosystems* has been developed to enable learners to build further on their understanding of natural ecosystems and how that understanding can be applied to make the conventionally managed agricultural systems function at a greater degree of integrity. The subject has been so designed that learners explore the biotic and abiotic relationships in natural environments and apply this understanding in the context of agricultural-landscape management. In achieving constructive alignment between learning activities and assessment tasks, the subject ensures the devel-

opment of skills in applying ‘systems’ principles in the evaluation of diverse management options and to demonstrate them in the research assignment by drawing worthwhile conclusions and meaningful connections in the context of their likely impacts in terms of productivity, stability, social equity, economics, and natural-resource management.

Capability-based education is well represented in the literature and practice of university education (Stephenson and Yorke, 1998). The capability approach seeks to equip learners to take full responsibility for their educational and personal development and in doing so, it provides the most appropriate learning environments for learners to achieve their goals (Raman, 1998). Capability is gaining justified confidence in one’s ability to act appropriately, communicate effectively, collaborate with others and learn from others’ experiences from familiar and unfamiliar circumstances (The Royal Society for the Encouragement of Arts, Manufactures, and Commerce, 1980). Learning to handle complex situations in unfamiliar contexts and manage them effectively is the focal point in the capability approach to education (Stephenson, 1998). The capability approach promotes the habits of reflection and self directed learning and more importantly, the seven ‘rural management capabilities’\*\* espoused at CSU–O are considered vital for a well-rounded rural manager with a commitment to sustainability. Upon graduation our former learners express unique integrations of these qualities in their practice.

In keeping with the principles of capability-based approach *Managing Agroecosystems* has been designed to facilitate learning with motivation. The semester-long research task has

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\*\* Rural management capabilities: (i) critical and creative thinking, (ii) communication, (iii) leadership and teamwork, (iv) ethical, social, and professional understandings, (v) management skills, (vi) personal and intellectual autonomy, and (vii) information literacy.

played, and continues to play, a vital role in the assessment design. As learners develop and execute their response to the research-based tasks, they learn to apply ecological theory in specific real-life contexts of Australian agricultural management. Assignments 1 and 3 require the learners to demonstrate their understanding of the most vital elements of ecological literacy, viz., interdependence, flexibility, and diversity (Capra, 1996; Cochrane *et al.*, 2007) and their ability to make reasonable and convincing meanings by relating them to the specific context of their research task. While executing their research-based assignments, they demonstrate their capability to think beyond the immediate time and into the future. *Managing Agroecosystems*, thus, encourages reflective learning through engagement with one contemporary real-life issue that requires intelligent management of an agricultural issue with appropriate ecological concepts. This subject provides a platform for equipping learners with the abilities not only to think, differentiate, and rationalize, but also to handle and solve unfamiliar problems in unfamiliar contexts by determining the problems and ways to resolve them. By constructing a programme at the intersection of the disciplines, viz., ecology, agriculture, and management, *Managing Agroecosystems* has enabled the development of empowered graduates, who, over these years, have proved employable and endowed with various functional efficiencies.

### Conclusion

Our Earth is experiencing human-induced environmental pressures of unprecedented intensity. Agriculture in its diverse forms is a significant contributor to that trend. In a small yet significant way the teaching of *Managing Agroecosystems* within the context of sustainable development has the potential to play a pivotal role to

lay an alternative, viable future.

We have sought to demonstrate how one subject, *Managing Agroecosystems*, goes to the heart of the problem – knowing how to restrict ecological decline in agricultural contexts and how to extend ecological frameworks to better manage agriculture for a sustainable Earth. The capability development philosophy underpinning the SAP has created an educational design, evident in *Managing Agroecosystems*, in which learners, as either current or future managers of agricultural ecosystems, develop not only the capacity to find more appropriate approaches to agricultural land use, but also develop understanding of the human factors involved in bringing about micro- and macro-scale changes.

### Acknowledgements

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**Research Paper**

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## Development and Evaluation of an Activity to Teach Molecular Phylogeny, Deep Time and Classification Systems for Japanese High School Students

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In this study, we attempted to develop a teaching material about molecular phylogeny, deep time and classification systems to Japanese high school students. On the basis of the pre- and post-test results and the positive impressions of the activity by students and teachers, our protocol was considered useful for teaching these macroevolutionary concepts. Combined use of this activity and other materials (e.g. Westerling 2008) to teach the accumulation mechanism of neutral variations in DNA molecules will promote understanding of the link between DNA and biodiversity.

Keywords: *deep time, mammalian evolution, molecular phylogeny, molecular clock, neutral theory*

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### Introduction

Many studies on evolution education have concentrated on microevolutionary topics (Catley 2006). However, research on teaching macroevolution has been actively performed, primarily in the USA. The major scope of these studies was to understand how to effectively teach the topology of phylogeny, that is, 'tree thinking' (Baum *et al.* 2005, Meisel 2010, Morabito *et al.* 2010).

There are three issues to promote teaching macroevolutionary topics in evolution education. First, research on how to teach phylogeny, particularly molecular phylogeny, is lacking particularly in non-English-speaking countries. Most teaching materials about molecu-

lar phylogeny have been developed in English-speaking countries (e.g. Maier 2001, Kuzoff *et al.* 2009, Franklin 2010, Lents *et al.* 2010, Kvist *et al.* 2011). Molecular phylogeny is an essential tool in current biological studies, and consequently, topics related to molecular phylogeny are included in many biology textbooks for both high school and university students (Cain *et al.* 2002, Campbell and Reece 2005, Raven *et al.* 2005, Sadava *et al.* 2009). In addition, the development of effective teaching materials for molecular phylogeny is strongly required because related topics, such as the neutral theory, molecular clock and effects of natural selection on molecules, appear difficult for students to compre-

hend (Ware 2008, Yamanoi *et al.* 2012a).

Second, materials for teaching deep time are required (Hills 2007). Catley and Novick (2009) indicated that American university students did not understand deep time irrespective of their biological background. Teaching the construction of a molecular phylogenetic tree and the calculation of the divergence time using a molecular clock in parallel can be an effective method of teaching deep time.

Third, materials for teaching biodiversity are necessary to promote its conservation. Classification is one of the important basic concepts for understanding biodiversity. Activities to teach these three contents (molecular phylogeny, deep time, and classification) to students simultaneously have not been developed, although there are many activities to teach molecular phylogeny (Maier 2001, Campo and Gracia-Vazquez 2008, Kuzoff *et al.* 2009, Franklin 2010, Lents *et al.* 2010, Kvist *et al.* 2011).

Biology education based on the new Japanese national curriculum framework, the Course of Study (CS), and its guidelines for secondary schools is being implemented in high schools in 2012 (Ministry of Education, Culture, Sports, Science and Technology 2009). This new CS places a greater emphasis on links between micro- and macro-biology and evolution (Shimada 2010, Yamanoi *et al.* 2012b). For instance, contents on molecular evolution (e.g., the neutral theory, molecular phylogeny, the molecular clock) and taxonomy (e.g., domain) are included in the new CS. Understanding molecular phylogeny, deep time and classification systems will promote biology education based on the new CS. However, effective teaching materials linking micro- and macro-biology have hardly been developed in Japan.

Our goal in this study was to develop an effective activity which can teach molecular phylogeny, deep time and classification systems simultaneously. Kuzoff *et al.* (2009) developed an excellent protocol of molecular phylogeny for inquiry learning using a free software MEGA (Tamura *et al.* 2007). In this study, we translated this protocol into Japanese and then modified it by incorporating two additional activities: the calculation of divergence time using a molecular clock and the examination of the classification of mammalian species thorough the Internet. We verified the effectiveness of this new activity for Japanese high school students by comparing their test scores before and after its implementation. Moreover, we conducted a free training course of this teaching protocol for Japanese high school biology teachers and administered questionnaires to reveal the effectiveness from the teachers' perspectives.

## Methods

### *Question for Inquiry Learning*

The following question was used for students: 'Which species are more closely related to whales in mammals?' This question was proposed by Kuzoff *et al.* (2009) for students' question when they depict molecular phylogeny, and it is also seen as a column in one biology textbook for Japanese high school students. We assumed that this question was suitable for many Japanese students because they were familiar with mammals.

### *Molecules, Species and Topology*

Kuzoff *et al.* (2009) recommended using the amino acid sequence of cytochrome c oxidase subunit 1 when answering the above-mentioned question. However, in this study, the amino acid sequence of alpha-globin chain was used for constructing phylogenetic

trees because this molecule can be utilized as a molecular clock (Barton *et al.* 2007, Futuyma 2009) and most Japanese students are aware of this molecule because the structure and function of hemoglobin are described in all Japanese biology textbooks for high school students (8/8 textbooks). We chose protein sequence data instead of DNA sequence data for constructing molecular phylogenetic trees because the amount of protein sequence data registered was small compared with that of DNA sequence data and it appeared to be easier for Japanese students to obtain relevant data in an English database; we used those of the National Center for Biotechnology Information (NCBI).

We selected seven mammalian species (minke whale, sperm whale, hippo, cat, kangaroo, quoll and platypus) for constructing molecular phylogenetic trees. From this topology, we expected students to learn two important topics, namely rough systematics of mammals (monotreme, marsupial and placental mammals) and convergent evolution (cat and quoll), in addition to answering the above-mentioned question. However, this topology would be invalid if another species (e.g. human, camel) were added to these seven species because the peptide length of alpha-globin is short and does not contain sufficient genetic information to create a valid topology. In summary, these species were arbitrarily selected to teach the above-mentioned concepts (rough systematics of mammals, convergent evolution).

### **Japanese Protocol for Students**

We translated the protocol of Kuzoff *et al.* (2009) into Japanese with some modifications.

First, in our protocol, we did not use Basic Local Alignment Search Tool but repeatedly inputted the scientific and protein names in the

search bar of the NCBI search engine (web-based resource) because we considered it might be difficult for Japanese students to find valid protein sequences in English databases.

Second, students additionally examined the protein sequence differences between species using MEGA as a source for estimating the divergence time (Fig. 1).

After constructing phylogenetic trees, students calculated the divergence time using the differences in protein sequences between species and the alpha-globin molecular clock. The rate of amino acid substitution in alpha-globin (the number of amino acids: 141) is estimated to be  $1.2 \times 10^{-9}$ /amino acid positions/year (Kimura 1983, Barton *et al.* 2007). Thus, the average time required for one amino acid substitution is calculated to be approximately 'six million years.' Students used this numeric value to calculate the divergence time between minke whale and sperm whale and that between the common ancestor of these whales and the species (hippo) most closely related to whales among the rest (five mammalian species).

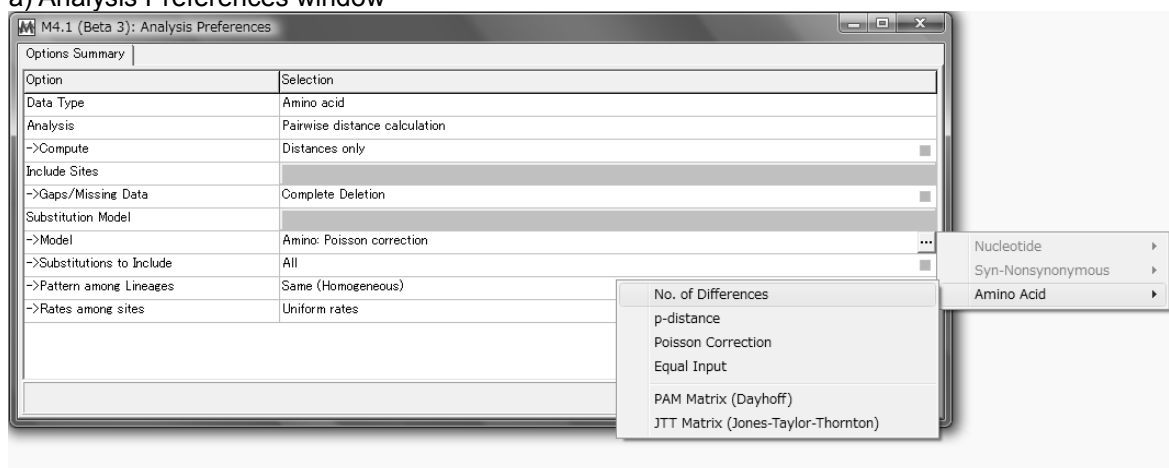
Third, we introduced a 'taxonomic sheet' (Fig. 2). Students examined the classification (kingdom, phylum, class, order, genus and species) of seven mammals through the Internet and depicted the topology on this sheet.

Fourth, pictures of these seven species provided on the students' protocol were pasted on the tip of the phylogeny depicted by students on the taxonomic sheet (Fig. 2). We believe that these pictures would increase students' motivation for this activity.

### **Student Activity**

We performed the activity for Japanese students (N = 60, male: 16, female: 44) at three Japanese high schools from October to December 2010 (High School A: N = 20, High

a) Analysis Preferences window



b) Pairwise Distance window

	1	2	3	4	5	6	7
1. <i>O. anatinus</i> HBA							
2. <i>B. acutorostrata</i> HBA	45.000						
3. <i>H. amphibius</i> HBA	41.000	26.000					
4. <i>M. giganteus</i> HBA	46.000	39.000	28.000				
5. <i>D. viverrinus</i> HBA	46.000	42.000	32.000	22.000			
6. <i>F. catus</i> HBA	43.000	31.000	24.000	30.000	35.000		
7. <i>P. catodon</i> HBA	46.000	18.000	21.000	36.000	35.000	35.000	

**Figure 1** How to examine amino acid differences between each species using MEGA

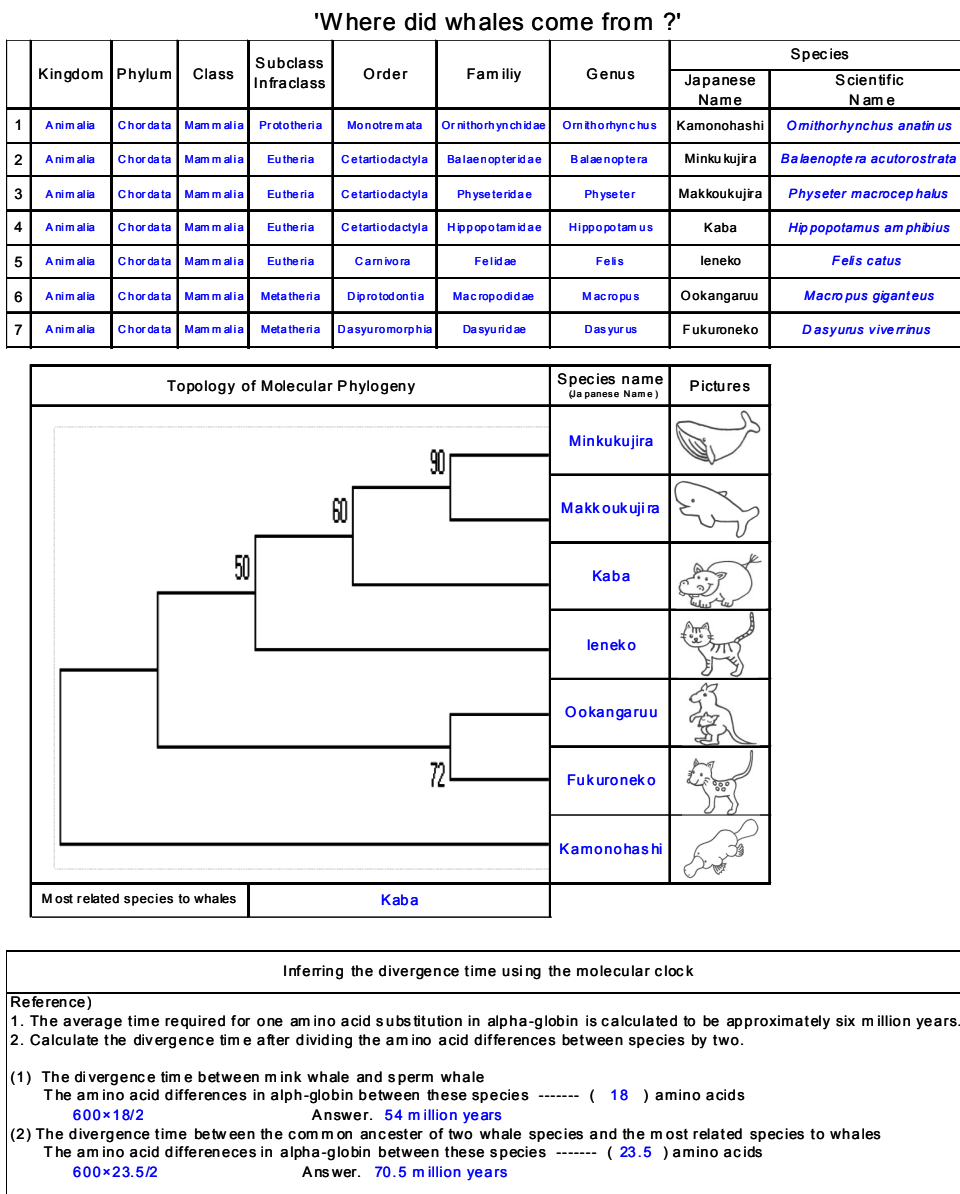
From the ‘Distances’ menu at the top of the MEGA window, select ‘Compute Pairwise.’ When the ‘Analysis Preferences’ window (a) opens, click the box on the right side of the ‘Model’ bar and select ‘Amino Acid’ and ‘No. of Differences.’ A table presenting the amino acid differences between each species will then appear in the ‘Pairwise Distances’ window (b).

School B: N = 23, High School C: N = 17). Two class hours (100 min) were used for this activity. These students were science majors and had previously studied evolution and molecular biology, including molecular phylogeny, the neutral theory, the molecular clock, the molecular structure of hemoglobin and classification systems, through normal lectures and textbooks.

Before the student activity, a teacher explained the following two points because this information is not adequately provided through normal biology class lectures in Japanese high schools. As biology textbooks with outdated scientific theories about evolutionary mecha-

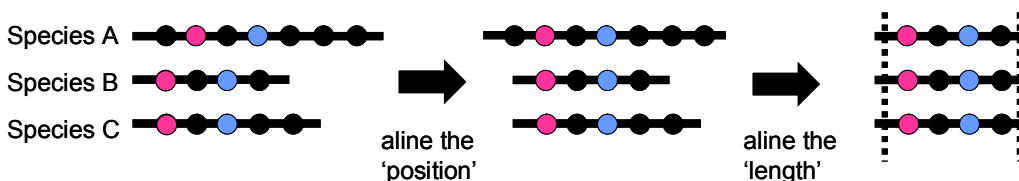
nisms were used in Japanese high schools (Yamanoi 2008, Yamanoi *et al.* 2012b), it was considered that students did not have enough opportunity learning about neutral theory (including multiple sequence alignment).

(1) Some protein sequence regions have varied during evolutionary history by genetic drift because they are neutral to protein function, whereas the other regions have been conserved by stabilized selection because they are vital to the protein function. If these essential regions are changed by mutation, the organism will die. Thus, you can depict molecular phylogeny by utilizing neutral variations of the protein sequence.



**Figure 2 Taxonomic sheet**

Students provided the classification of seven mammalian species, depicted the molecular phylogeny of these species, and pasted digital pictures cut from the student’s protocol (mammal illustration drawn in this figure are shown as samples). In addition, they calculated the divergence time between two whale species and that between a common ancestor of these whales and hippo using the alpha-globin molecular clock. The blue characters and the topology with bootstrap values illustrate examples.



**Figure 3 An illustration used for explaining multiple sequence alignment**

Circles represent amino acids. Different colours represent different amino acids.

(2) You perform ‘multiple sequence alignment’ after downloading the amino acid sequences of alpha-globin in seven species that are used for constructing molecular phylogenetic trees. Multiple sequence alignment is a method that aligns the peptide lengths and amino acid sequences of alpha-globins among species (Teachers can use Figure 3 to explain this method). Some mutations, such as deletions and insertions, alter the peptide length of the protein. Thus, the peptide length of alpha-globin differs among species.

To start the student activity, students were divided into pair groups (two students per group). We asked the students groups to answer the question “Which species were more closely related to whales in mammals?” presented previously and to determine which species are closely related to each other by comparing their pictures. We then prompted students in each group to determine their roles: one student downloaded the protein sequences and the other examined the classification of each mammal through the Internet. The students exchanged roles after downloading the amino acid sequences of three or four species. The students managed to complete this activity by reading the protocol and confirming the procedure with their partner without any teacher’s help.

An example of a molecular phylogeny depicted by students is shown in Figure 2. After constructing the phylogenetic tree, the students calculated the divergence time using the following formula: **the number of amino acids being different between species/2 × 6 (million years)**. The divergence time between minke whale and sperm whale was calculated to be 54 million years and that between the common ancestor of these whales and hippo was calculated to be 70.5 million years.

Because minke whale and sperm whale, and the common ancestor of whales and hippo are considered to have diverged approximately 33 and 60 million years ago, respectively (Gatesy 2009), the values estimated in this activity are not valid. However, we considered these values useful for students to understand the deep time necessary for macroevolution. To prevent students from keeping these values as their knowledge, a teacher explained after the activity that these values were rough estimate values inferred from only one molecular clock, and that we needed to use more information to get more precise values through estimations by other molecular clocks and fossil records.

#### *Evaluation of the Activity Using Pre- and Post-Test*

We made a test that included 13 questions to evaluate this activity (Box 1). The main topics of the test were molecular evolution, the molecular clock, the timescale of macroevolution and classification systems. The same test was conducted before (pre-test) and after carrying out the student activity (post-test). We did not tell students to do post-test until finishing the student activity. One point score was given to each correct answer (maximum score: 13). The pre- and post-test scores were compared by paired *t*-test and Wilcoxon’s signed-rank test using the statistical software Systat 8.0. We also evaluated their impressions after this activity with some questions and descriptions (Box 1).

#### *Evaluation of the Activity by High School Biology Teachers*

For popularization of this teaching protocol, it must be considered effective by both students and teachers. We held a workshop of this activity for Japanese high school biology teachers without charge. We invited teachers and communicated with them via a mailing list

network of Japanese biology teachers prior to the workshop.

In the training course, we requested teachers to perform the activity in the same

### Box 1 Questionnaire for students

A. Fill in the blank ( ) or circle the appropriate in [ ].

Q1. Proteins are molecules that consist of ( ) by bounded together by peptide bounds.

Q2. Most organisms commonly bear certain proteins. [true/false/beyond comprehension]

Q3. Organisms are classified into the following, in sequence: kingdom, ( ), ( ), ( ), ( ), ( ), species.

Q4. Scientific name comprises a ( ) name and a ( ) epithet

Q5. Mammals are classified into three subgroups: ( ), ( ) and ( )

Q6. When amino acid sequences are compared between species A and B, amino acid sequences are perfectly identical. [true/false/beyond comprehension]

Q7. In particular genes, irrespective of species, DNA sequences and amino acid sequences of protein originated from the gene have changed at a constant rate during evolutionary history. [true/false/beyond comprehension]

Q8. Organisms with analogous morphology are not necessarily closely related species. [true/false/beyond comprehension]

Q9. Whales are more closely related to ( ) in mammals.

Q10. When same proteins are compared, their amino acid sequences show more resemblance among closely related species. [true/false/beyond comprehension]

Q11. When amino acid sequences are compared among some species, their sequences show both evolutionarily labile and hard-wired regions. [true/false/beyond comprehension]

Q12. We can calculate the divergence time between species using a molecular clock.

Q13. The average time spent in speciation is about

[one/one hundred/one thousand/ten thousand/hundred thousand/over million] year(s).

B. Evaluate this activity on a five-level rating system. Circle the appropriate in [ ].  
interesting [5 / 4 / 3 / 2 / 1] boring

increase understanding [5 / 4 / 3 / 2 / 1] not increase understanding

digital work difficult [5 / 4 / 3 / 2 / 1] easy

English expression of MEGA difficult [5 / 4 / 3 / 2 / 1] easy

C. Please write any of your impressions of this activity.

### Box 2 Questionnaire for teachers

A. Please fill in the blank ( ) or circle the appropriate in [ ].

1. Sex [male/female]

2. Teaching experience ( ) year(s)

3. Do you think this activity is easy to practice in high school biology class?

agree [5 / 4 / 3 / 2 / 1] disagree

4. Do you think you will practice this activity in your next year's biology class?

agree [5 / 4 / 3 / 2 / 1] disagree

B. Do you think this activity will help students understand the following contents?

Please circle the appropriate number.

'Molecular phylogeny' increase understanding [5 / 4 / 3 / 2 / 1] not increase understanding

'Molecular clock' increase understanding [5 / 4 / 3 / 2 / 1] not increase understanding

'Convergent evolution' increase understanding [5 / 4 / 3 / 2 / 1] not increase understanding

'Classification system' increase understanding [5 / 4 / 3 / 2 / 1] not increase understanding

'Mammalian evolution' increase understanding [5 / 4 / 3 / 2 / 1] not increase understanding

C. Please write any of strengths and weakness to this activity.

D. Please write any of your impressions to this activity.

manner as students and to complete a questionnaire (Box 2) for evaluating this teaching protocol. We also asked them to describe the strong points and weak points of the activity and to provide their impressions by descriptions (Box 2).

## Results

### *Evaluation by the Students Pre- and Post-test*

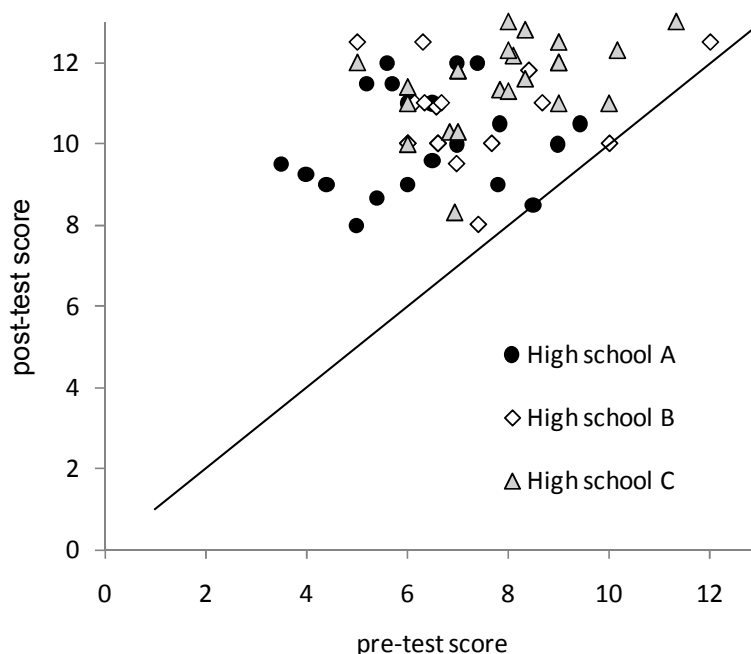
The average score of post-test was significantly higher than that of the pre-test (Figure 4; paired *t*-test,  $df = 59$ ,  $t = -16.19$ ,  $p < 0.0001$ ). The average pre-test and post-test scores were 7.2, 10.8, respectively. In addition, the scores of nine questions out of 13 showed a significant rise after the activity, whereas there was no questions whose scores showed a significant fall (Figure 5, Wilcoxon's signed-rank test).

The students' impressions after the activity are presented in Figure 6. Most students be-

came more interested in molecular phylogeny through this activity, and their understanding of molecular phylogeny was deepened (Fig. 6 a–b).

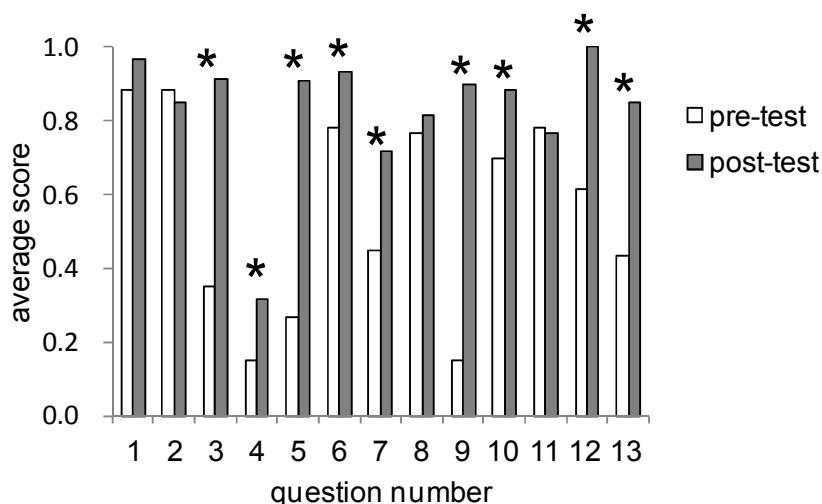
We checked all of their descriptions at several times and extracted common impression. Their impressions ( $n > 2$ ) were categorized as follows (some students' descriptions were distributed to several categories): understood that it is not always possible to judge evolutionary relationships between species only by phenotypes ( $n=13$ ), surprised that whales and hippo were most closely related among the shown species despite being found in different habitats ( $n = 11$ ), found depicting molecular phylogeny to be easier than expected ( $n = 7$ ), understood molecular phylogeny better ( $n = 5$ ), wanted to depict another molecular phylogeny ( $n = 4$ ), and thought that the use of computer included any difficulties ( $n = 4$ ).

Conversely, Figure 6 also shows that ap-



**Figure 4** Comparison between the pre- and post-test values

The straight line in the graph indicates  $y = x$ . Thus, plots above this line represent rises in scores after the activity.



**Figure 5** Changes in the average correct answer ratio for individual questions

Asterisks indicate significant differences between pre-test and post-test at the 5% level.

proximately a half of the students felt the digital practice and the English expressions of MEGA were difficult to comprehend (Fig. 6 c–d).

#### **Evaluation by High School Biology Teachers**

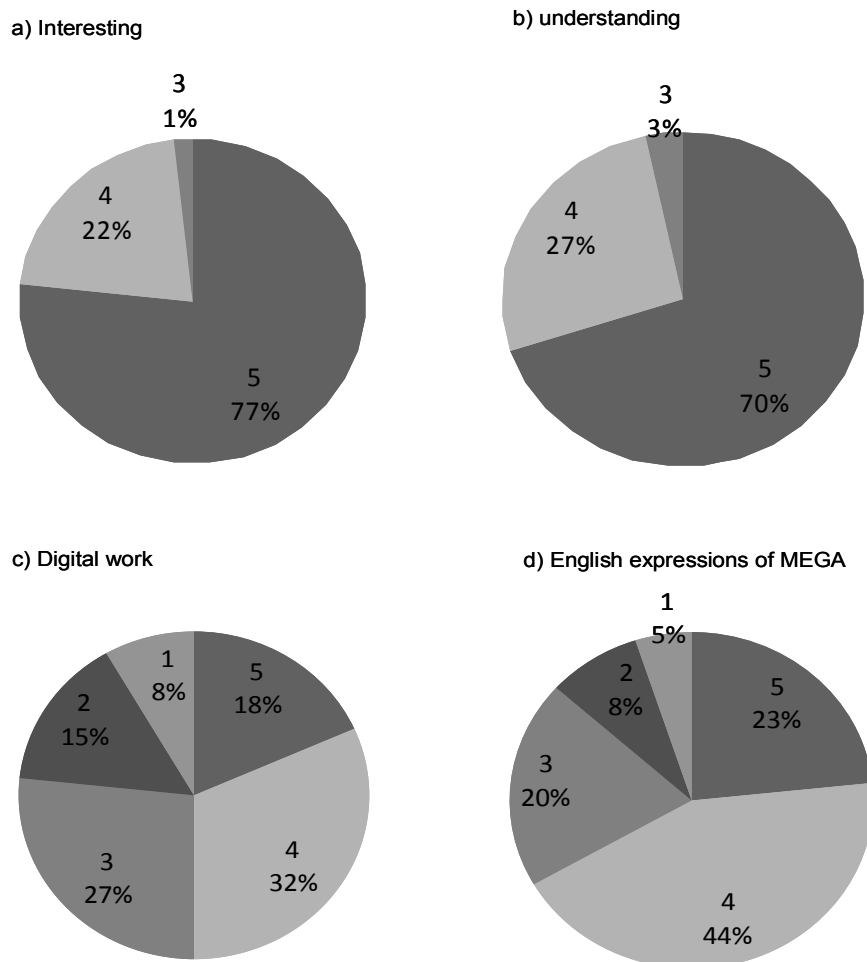
Twenty-six teachers with an average teaching experience of 16.2 years participated in this course (male: 16, female: 8, no description about sex: 2). They positively evaluated the designed activity (Fig. 7). Most of them answered that they wanted to implement this activity in their next year's classes and that this activity was useful for teaching molecular phylogeny.

More than two teachers pointed out four strong points of the activity: students will be able to understand contents related to molecular phylogeny through hands-on activity, which is difficult to understand through only lectures ( $n = 8$ ); students will be able to have a researcher-like experience ( $n = 4$ ); the visualization of the differences in protein sequences among species will be easier because students will actually use colourful depiction ( $n = 3$ ); and this activity could be useful to understand evolution especially in Japan where teaching

materials for evolutionary biology are scarce so far ( $n = 3$ ). In addition, the teachers noted two drawbacks of this activity ( $n > 2$ ): the English expressions of MEGA were difficult to understand ( $n = 6$ ) and this activity was useful only for students wishing to proceed to higher education ( $n = 3$ ). Other descriptions ( $n > 2$ ) were interesting ( $n = 5$ ) and inspiring ( $n = 3$ ).

#### **Discussion**

Increase in the students' understanding of molecular evolution (Box 1: Q 6, 7, 10 and 12), deep time (Q 13) and taxonomy (Q 3, 4, 5) resulted in a higher average test score after the activity. On the basis of these test results and the positive impressions of the activity by students and teachers, our protocol is considered to be useful for at least to Japanese high school students to study these concepts. The students' descriptions in the questionnaire suggested that the activity was effective for understanding convergent evolution and homoplasy. While the activities on molecular phylogeny developed so far were mostly designed for university students in English-speaking countries (Kuzoff *et al.* 2009, Franklin 2010, Lents



**Figure 6** Students' impressions after the activity

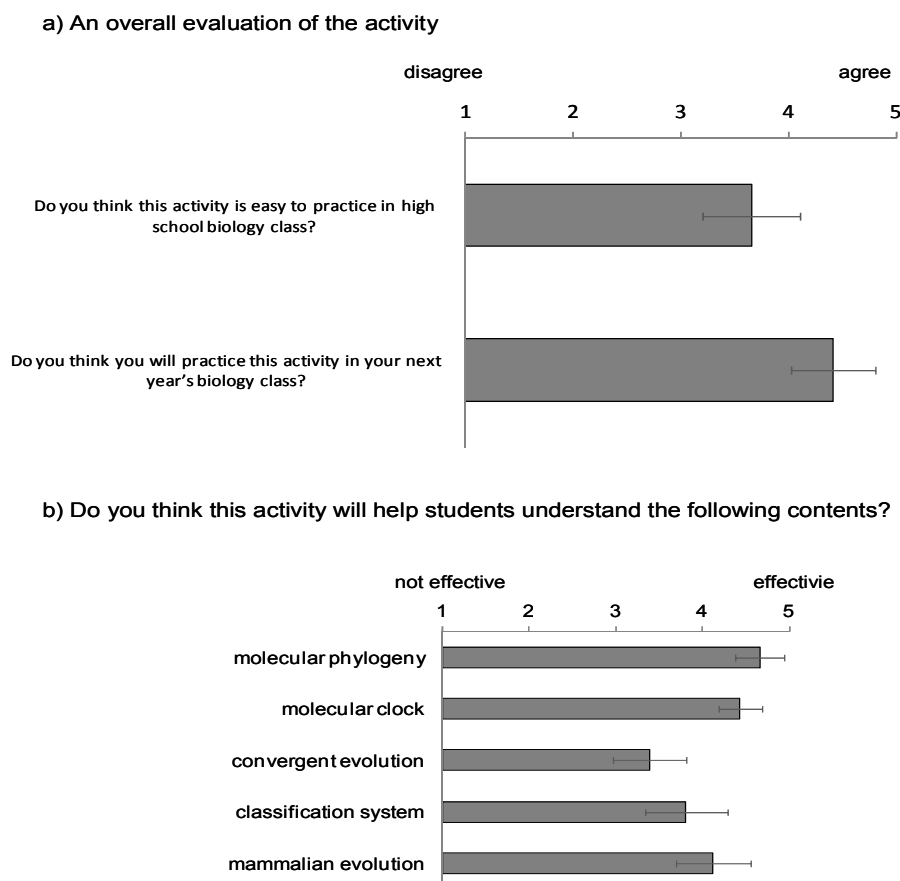
Students graded their impression on a scale of one (negative) to five (positive) (see Box 1 for the scale).

*et al.* 2010, Kvist *et al.* 2011), our activity was shown to be effective for high school students in one non English-speaking country. Because misconceptions about deep time and homoplasy among university students in the USA have been reported (Catley and Novick 2009, Morabito *et al.* 2010), our activity may be effective for high school students and university students in countries other than Japan.

However, some students and teachers felt the English expressions of MEGA were difficult to comprehend. Although this activity offers a valuable opportunity for Japanese students to notice the importance of English in

scientific research field, it would be more valuable to many students and teachers if a Japanese version of MEGA be developed.

The development of this activity is one of the important steps in teaching the links between micro- and macro-biology and evolution. This activity does not include learning how amino acid variations in a particular protein molecule among species arose. Therefore, combined usage of this activity and other teaching materials about the accumulation mechanism of neutral variations in molecules (e.g. Westerling 2008) will lead to further understanding of the links between DNA and



**Figure 7** Biology teachers' impressions after carrying out the practice

Teachers graded their own impression on a scale of 1 (negative) to five (positive).

biodiversity.

### Acknowledgements

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## Abstracts of the Papers Presented at the 23rd Biennial Conference of the AABE

The 23rd Biennial Conference of the AABE was held at the National Institute of Education, Nanyang Technological University, Singapore, from 18 to 20 October, 2010. The theme of the Conference was “Biology Education for Social and Sustainable Development.” More than two hundreds people from seventeen countries including outside of the Asian region attended (Figure 1).

There were six keynote lectures, seven country reports, one workshop and 93 oral and poster presentations. Some papers presented at the conference were compiled by the co-organizers of the conference, Dr. Mijung Kim and Dr. C. H. Diong. The book, *Biology Education for Social and Sustainable Development*, was published in 2012 by Sense Publishers, Rotterdam, Netherlands.

Although the readers can read the abstracts of the papers published in the above-mentioned book,

all abstracts which were compiled in the 23rd Biennial Conference Proceedings\* are included in this issue.

\*Diong, C. H. and Kim, Mijung (Eds.) 2010. Book of Abstracts: Biology Education for Social and Sustainable Development, of the Asian Association for Biology Education. National Institute of Education, Singapore. 93 pp.

<Keynote Lectures>

### Biology Education in the Future

Robert L Wallis

University of Ballarat, Australia

Biology today is a popular and influential discipline that dramatically shapes our lives and affects the development and operations of societies around the world. Biology educators thus play a crucial



Figure 1 Attendants of the 23rd Biennial Conference of the AABE.

role in ensuring the global community is made aware of the biological bases of everything we do. However, as biology teachers and educationists, we face unprecedented challenges in making our discipline relevant, meaningful, attractive and respected.

Some of the challenges include: (i) the explosion of knowledge and the feeling that we are being over-whelmed by new developments and applications, (ii) the challenges to the scientific method from fundamentalist and other groups, (iii) the urgency of challenges that confront society, so that long term solutions are less considered than immediate, short-term ones, (iv) the shift to more applied studies that do not have the intellectual rigour that underpins disciplines like biology, and (v) specialization of the disciplinary components of biology and the challenge to integrate and generalize.

On the other hand, I am optimistic about the future importance and potential success of biology education. Some guiding principles may need to be followed – these include, ensuring relevance, using the latest educational technologies, wisely, stressing the applications as well as the discovery aspects of science, and ensuring biology makes meaningful contributions to economic, social, cultural and environmental sustainability. Examples will be used to illustrate applications of these and other principles.

**From Gene to Education – The ECNG  
Research Framework: Education,  
Cognitive Psychology, Neuroscience,  
and Molecular Biology**

**Chun-Yen Chang**

*National Taiwan Normal University, Taiwan*

In the past decade, genetic and neuroscience research have provided some of the most exciting breakthrough for cognitive science and education. In our opinion, the integration of multiple disciplines (ECNG research framework, education, cog-

nitive psychology, neuroscience, and genetic or molecular biology studies) can serve to inform researchers in different areas, in terms of furthering their own research and deriving meaningful thoughts/implications and practice for learning sciences, rather than merely providing a powerful means for exploring the mechanism of human behavior. In this presentation, I would like to present this interdisciplinary research framework, briefly review related theories, and present our preliminary work in exploring the associations between genotypes and student science achievement. Our profound hope is to integrate researchers in different fields in order to explore the mechanism of learning and to provide concrete evidence of ways in which students' learning can be improved.

**Biology Education in Mainland China  
2000-2010: A Review and Assessment  
of Curricular Trends and Teacher  
Preparation Models for a Changing  
Society**

**Enshan Liu**

*Beijing Normal University, China*

With the shift from a centralized planned economy to a market economy, drastic changes in society have occurred at the end of the 20th century in mainland China. It was apparent that our school education needed to change for meeting the challenges of this changing society. Education reform started in the year 2000, aiming to prepare school children as a new generation for a new biocentury. As a part of the school curricula, biology teaching reforms focused on transitioning from a content-oriented to inquiry-based learning environment. In the last 10 years, we experienced mainly three phases of the change: determining and developing new national school biology curricula and teaching materials (for both middle school and senior high school), trial implementation of the new curricula, and implementation to all schools.

From the beginning of this biology curricular reform, helping teachers to change beliefs and their own teaching strategies and styles has been a main theme in the reform process. The challenges that were encountered in the biological sciences curriculum reforms and innovation were not limited to the provision of effective teacher professional development, but also to modeling and encouraging an appropriate educational environment, including evaluation on student learning outcomes and the determination of what constitutes excellent and effective teaching for biology teachers.

### **Promoting Public Understanding of Sustainable Development: Opportunities for Science Education**

**Merle C. Tan**

*UP National Institute for Science and Mathematics Education Development, Philippines*

The concept of sustainable development is not easily appreciated by many. However, it is an important concept in the development of an empowered citizenry so that they make sustainable practices a way of living. An empowered citizenry is considered scientifically, technologically, and environmentally (STE) literate. It is in this context that countries are enjoined to pay attention to the development of science education programs that facilitate acquisition of STE literacy, foster patriotism and nationalism, accelerate social progress, and promote total human liberation and sustainable development. Such program should adhere to the idea that “if we take care of environment, it will take care of us.” The paper will discuss an STE-based, inquiry-based science education curriculum for basic education and discuss its implications to teacher education. Finally, the paper will focus on how integrative biology education with relevant community programs promotes environmental protection and conservation of its resources for the present and future generations. Children will have opportunities to share what they

have learned in school to their families and community.

### **Linking Education to Socially-Relevant Bioentrepreneurship for Sustainable Development**

**Paul P. S. Teng**

*National Institute of Education,  
Nanyang Technological University, Singapore*

The 21st century has been called a “Biology Century” because of the many advances in humankind’s understanding of the basic processes and components of life. At the same time that exciting discoveries and applications based on biology have been made, the lingering problems of hunger and poverty among a quarter of humankind still remain. The United Nations, Food and Agriculture Organization has estimated that over 800 million children go to bed hungry every night and more than one billion people live on less than one US\$ per day. Clive James, the chair of an international organization ([www.isaaa.org](http://www.isaaa.org)) has warned that in the next 50 years, humankind will consume as much food as has been consumed since the beginning of agriculture 10,000 years ago. Profound challenges face the world even as we advance technologically. Biology offers great scope to meet these challenges, especially in the assurance of food security, and in the use of biology to meet the needs for more fuel, fiber and animal feed – the 4F’s.

The 20th century saw humankind dramatically expand in the diversity and magnitude of bioscience enterprises, i.e. enterprises which create value using biology. These bioscience enterprises include raw bio-commodities like rubber and palm oil produced using modern plantation technology, high quality seed material using hybrids, high quality seed material using tissue culture, biofermentation, biofertilizers, biopesticides, biofuels, bioremediation and biotech seeds. Each of these enterprises is based on sound science and contributes to key

needs of modern societies. However, technology and entrepreneurship together are not enough, and require andragogy and pedagogy through education programs developed for specific target groups, ranging from school children to uneducated farmers. Science education generally, and biology-focused education specifically, at the school level need to be linked to “real-world” situations to have relevance to societal issues. For example, teaching biology in a rural school without relating it to the cropping systems surrounding the schools will not contextualize the learning or highlight the relevance of biology to meet local needs. Urban societies need to be made aware of where their food, feed and fibre originate and the dependency of the production systems on environmental sustainability. In this respect, Science Centres are pivotal to the broader education of the citizenry to ensure continued support of the rural base that feeds cities. Similarly, the rapid pace of scientific and technological advances requires that adult education programs – mainly implemented by extension systems – be designed with simplicity to facilitate the adoption of new seeds and modern agronomy.

**Actions and Opportunities: A North American Perspective on Biology Education for Social and Sustainable Development**

**Margaret Waterman**

*Southeast Missouri State University, USA*

Educating for social and sustainable development within the biology curriculum is an area of much interest globally, providing great opportunity for the incorporation of new content, new teaching approaches and new collaborations among biologists and educators around the world. It is an area where people are already taking action as they create new curriculum and learn to meaningfully engage students in understanding the complex issues and interrelationships underlying successful

sustainable development.

In this talk, I will provide an overview of educational work by North American to address the issues of social and sustainable development in undergraduate biology curricula and teacher preparation, including organizations, programs, and courses. The leading organization helping biologists make these kinds of changes in the U.S. is the National Center for Science and Civic Engagement, of which SENCER (Science Education for New Civic Engagements and Responsibilities) is their premiere program. This organization provides faculty institutes (extended workshops), small grants, model course syllabi, regional networking, and publication opportunities. They have played a key role in helping scientists see how to connect social issues, such as health and disease or economic development, to science courses.

In addition to describing some completed projects, I will talk about some of the changes in teaching approaches that can facilitate integration of concepts and issues of sustainable development. In this session, I will describe and illustrate the use of investigative cases (a type of Problem Based Learning) for engaging students with realistic situations, real data and scientific tools related to decisions about sustainability. Using realistic situations, or cases, provide a context and setting within which learning occurs. For example, the large cities of the U.S. desert need more water than is available from rivers. They are using water from aquifers more quickly than it can be replaced. How can this problem be addressed for the long term in a socially just way? After analyzing the case, students would be introduced to relevant tools, simulations, models and data sets that they can use to investigate their questions and develop rational decisions.

Investigation realistic cases with the tools and data of science will provide one approach to addressing the opportunities awaiting us to teach about sustainable development in a wide variety of academic settings.

<Country Reports>

**Characteristics of the New Course of  
Study for Upper Secondary School  
Biology  
Education in Japan**

**Teiko Nakamichi**

*Society of Biological Sciences Education, Japan*

The revision of the Course of Study (CS) by the Ministry of Education, Culture, Sports, Science and Technology has been carried out about every ten years. The latest revision of the CS for elementary and lower secondary schools was announced in 2008 and the revised CS will be implemented in 2011 for elementary schools and in 2012 for lower secondary schools. The new CS for upper secondary schools was announced in 2009. Revisions in mathematics and science will be implemented from 2012, one year earlier than for the other subjects.

The new CS for upper secondary school biology comprises "Basic Biology: Science for All" (a 2-credit subject) and "Biology: Science for Interested Students" (a 4-credit subject). Basic Biology, in which significant change was accomplished, is organized into three units: (1) Organisms and genes, (2) Maintenance of internal environment, and (3) Biodiversity and ecosystems. Key words for Basic Biology are DNA, Health, and Environment. In addition, Basic Biology emphasizes concepts of "Unity and Diversity" related to Evolution. Biology is organized into five units: (1) Life phenomena and substances, (2) Reproduction and development, (3) Environmental response, (4) Ecosystems and environment, and (5) Evolution and phylogeny. Despite an abundance of knowledge provided by current biological research, the contents of upper secondary school biology have remained static until now. Our mission is to inform secondary school teachers of the new contents and to prepare instructional materials for teaching the new contents.

**Keywords:** *Basic Biology, DNA, Evolution, Environment, Health, Unity and Diversity*

**Cambodia Profile and  
Biology Education in Cambodia**

\*Chansean Mam<sup>1)</sup>, Morimoto Koichi<sup>2)</sup>

<sup>1)</sup> *National Institute of Education, Cambodia,*

<sup>2)</sup> *Nara University of Education, Japan*

Kingdom of Cambodia located in Southeast Asia shares the borders with Thailand, Lao and Vietnam. The area of this country is 185,035 km<sup>2</sup> with the population of about 15 million and the official language is Khmer. Most of the Cambodian people are Buddhists. The Kingdom of Cambodia is named as Kingdom of Wonder; two temples are registered as world heritage Angkor Watt temple and Preah Vihea temple. Cambodian people experienced different regimes from 1960s to present. One nightmare regime was Pol Pot regime from 1970b to 1975; most of educated people were killed and died during that regime, and there was no education during that time. From 1975 to 1993 in Cambodia Republic, education in Cambodia started from nothing; there were no schools or teachers, and the people with little knowledge taught the people without any knowledge. From 1993 to present, Cambodia is a Multiparty Liberal Democracy Country.

Education in Cambodia started nothing in 1975, but from then, it was gradually developed. Cambodia had a big problem with science education, especially biology education. From 1975 to 2000, students studied biology without doing experiments or practical work at all, even though Cambodian teachers trained at National Institute of Education Singapore (NIE) had undergone training with laboratory and practical skills. From 2000 to present, high school students studied biology with some simple experiments or practical work that used simple local materials, and the teacher trainees in NIE have a chance to study biology with both simple experiments contained in secondary textbooks and difficult experiments using modern equipment.

**Keywords:** *education development, nightmare regimes, science experiment, world heritage*

## **Fostering Creativity and Sustainability through the 2009 Science Curriculum in Korea**

**Heui-Baik Kim<sup>1)</sup>, Sun-Kyung Lee<sup>2)</sup>**

<sup>1)</sup> *Seoul National University,*

<sup>2)</sup> *Cheongju National University of Education, Korea*

Fostering scientific literacy in citizens is one of main goals in science education, which includes higher thinking abilities such as critical thinking skills and creativity, and contributes to active participation in a knowledge-based, open society. Recently, education for sustainable development (ESD) has been considered a critical strategy for solving unsustainable issues in the world such as climate change and biodiversity, which stresses complexity and harmony among the social, economic and environmental perspectives in those issues. ESD is also emphasized to build competencies in critical thinking, reflective thinking, future thinking, system thinking and problem-solving based on sustainable literacy for achieving a sustainable future. The national curriculum revision in Korea conducted in 2009 highlighted the converging competencies of creativity and integrity as key competencies. The 2009b revision of the science curriculum tried to move it from the compartmentalized branches of science to re-organize the curriculum as a converging science under the themes of ‘cosmos and life’ and ‘science and culture.’ It was recommended to apply inquiry-based activities and STS-related science classes using various pedagogies, observation, experiment, investigation and discussion to cultivate creative problem-solving and rational decision-making abilities for the future. This paper will review the contents and pedagogies of the 2009 science curriculum to explore the contribution of converging science education for a sustainable society. In addition, possible methods for integrating sustainable literacy into scientific literacy will be explored to re-orient science education based on reviews of the detailed syllabus.

**Keywords:** *creativity, converging science, ESD, pedagogy, science curriculum, sustainability*

## **Biology Education in Schools Country Report - Australia**

**Anne M Wallis**

*Deakin University, Australia*

Australia is a federation of 6 states and 2 territories and each jurisdiction is responsible for its own curriculum design and implementation for all levels of schooling from Preparatory year through the Year 12. However, the Australian Government is currently working towards the introducing a new National Curriculum. If the current timelines for curriculum development are met, it is expected that the new science curriculum in Years P – 10 will be introduced in 2012 while in Years 11 and 12 a new biology curriculum will be introduced over a two year period beginning in 2013.

During the “compulsory” years of school, biology is taught through the discipline of Science, which constitutes a core study area from Prep to Year 10. Under a national system, science curriculum will be organized around three interrelated strands: science understanding; science inquiry skills; and science as a human endeavour. The biology component at this level will be developed around four themes: cells and living things, the human body, ecosystems and theory of evolution and the diversity of living things. For Years 11 and 12 the biology curriculum, as with the other sciences, will be developed around three themes: science understanding, science inquiry skills and science as a human endeavour. This report will investigate the new national curriculum while reflecting on the strengths of the current biology curriculum in Victoria.

**Keywords:** *Australia, national curriculum, VCE*

## **The Teaching of Biology in Singapore Schools: Past, Present and Future**

**Siew Ping Wang**

*Curriculum Planning and Development Division,  
Ministry of Education, Singapore*

The teaching and learning of Biology in Singapore

schools is presented. The development in this subject area parallels the historical and economic development of the country in general. This can be divided in the early years of a “survival phase” during independence and then to an efficiency-driven phase in the 1970s to the 1990s. From the late 1990s, the paradigm has shifted to a system which is more ability-based phase.

The early decades of the biological education mainly mirrors the development in the UK education scene, due very much to the historical education legacy and ties. The outlook of the teaching of Biology in schools then was based more on classical biology. From the 1970s onwards, biology education took on a more man-centred approach. And from the onset of the ability-based phase, there was a closer reflection of the changes in biology education in schools with the economic progress of the nation.

The emergence of the life sciences and its importance and rapid developments, as exemplified by the Human Genome Project in the new millennium, initiated a timely re-look at the school biological curricula. Keeping tabs of such a major scientific endeavour which has been heralded as the golden age of biology, as well as other equally important developments, e.g. global warming and conservation will be some of the key considerations in planning for a 21st century school biological education that will serve our future generations.

**Keywords:** *Biology, future, past, present, Singapore, school*

### **School Biology Education in Thailand**

**Wanida Tanaprayothsak**

*Institute for the Promotion of Teaching Science and Technology, Thailand*

Thailand has announced its Core Curriculum for Basic Education BE 2551 by defining the Learning Standard into eight Learning Areas, i.e. Thai Language; Mathematics; Science; Social Sciences, Religion and Culture; Health Science and Physical

Education; Arts; Career and Technology and Foreign Languages.

In each learning area, the learning (content) standard is defined to be the main target for the development of students' quality. The learning standard will indicate what students should know and be practicable, have desirable morality, ethics and values when they finish their basic education. Moreover, the learning (academic) standard is also an important mechanism in driving and developing the whole education system. The learning standard will reflect what is desirable, what have to be taught, how to teach and how to evaluate, etc.

The basic education is divided into four intervals: 1st Interval (Grade 1-3), 2nd Interval (Grade 4-6), 3rd Interval (Grade 7-9), 4th Interval (Grade 10-12)

The learning Area in Science is aimed at enabling learners to learn the subject with the emphasis on linking knowledge with processes, acquiring essential skills for investigation, building knowledge through investigative processes, seeking knowledge and solving various problems. Learners are allowed to participate in all stages of learning, with activities organized through diverse practical work suitable to their levels. There are eight main content areas (Strands)\*

Strand 1 Living things and processes of life

Strand 2 Life and the environment

Strand 3 Substances and properties of substances

Strand 4 Force and motion

Strand 5 Energy

Strand 6 Change process of the earth

Strand 7 Astronomy and space

Strand 8 Nature of science and technology

In each interval, there are indicators specifying what the students should know and be able to apply as well as the characteristics of students in each level. This will reflect the learning standard, be specific and concrete. It could be used to determine the context, fix the learning unit, manage the learning and teaching activities and act as main criteria for the evaluation of learners' quality.

There are two categories of indicators:

1. Grade-level indicators: It is aimed to develop the learners in each academic year of the compulsory education (Grade 1-9).
  2. Interval indicators: It is aimed to develop the learners in the last interval (Grade 9-12)
- Biology is composed of Strands 1 and 2. Each strand has its determined standards.

**Living things and processes of life:** Living things, basic units of living things, structures and functions of various systems of living things and processes of life; biodiversity, genetic transmission; functioning of various systems of living things, evolution and diversity of living things and biotechnology.

**Life and the environment:** diverse living things in the environment; relationships between living things and the environment; relationships among living things in the ecosystem; importance of natural resources; utilization and management of natural resources at local, national and global levels; factors effecting survival of living things in various environments.

Note: At the conference, Prof. Morakot Sukchotiratana of Chiang Mai University read the report.

### **Assessing the BS Biology Programs in the Philippines: A Commission on Higher Education (CHED) Initiative**

**Asyuncion K. Raymundo**<sup>1,3)</sup>,

**Florencia G. Claveria**<sup>2,4)</sup>, **Cesar G. Demayo**<sup>2,5)</sup>,

**\*Rosie S. Madulid**<sup>2,6)</sup>, **Joel M. C. Chavez**<sup>7)</sup>

<sup>1)</sup> Chair, <sup>2)</sup> Member, CHED Technical Committee for Biology, <sup>3)</sup> University of the Philippines, Los Banõs, College Laguna, <sup>4)</sup> De la Salle University,

<sup>5)</sup> Mindanao State University – Iligan Institute of Technology, <sup>6)</sup> University of Santo Tomas,

<sup>7)</sup> Commission on Higher Education, Philippines

Biology plays a pivotal role in the development of Science and Technology (S & T) in our country. It needs to be taught effectively and efficiently with a research-based nature. Toward this goal, the Commission on Higher Education (CHED)

developed and implemented CHED Memorandum ORDER (CMO) 24-S-2005, also known as the “Minimum Policies and Standards for Bachelor Science in Biology Program.” After five years of implementation, an evaluation of the condition of biology education in the Philippines in the light of CMO 24-S-2005 was done to examine the Higher Education Institute (HEI) compliance to the Policies and Standards, and to measure its effectiveness in bringing about better biology education. Results of this evaluation will be presented out of 167 HEIs identified in 2005 as offering the BS Biology Program. Analysis of data was based on curriculum, faculty, facilities, library, administration of the program and student population. Recommendations are presented for the CMO to achieve effectiveness in improving biology education in the tertiary level.

<Workshop>

### **Problem Based Learning (PBL): Modifications for Flexible Use in Biology Classes**

**Margaret Waterman**

*Southeastern Missouri State University, USA*

Problem Based Learning (PBL) is one of a family of teaching approaches that center science instruction around a case: a realistic situation told by people involved in some way in the issue. Other approaches in this family include case studies, investigative case based learning, and case-based learning. Because a story is their centerpiece and starting point, these methods engage groups of learners in case analysis, posing questions, information gathering and management, and proposing solutions to problems. For science teaching, it is important to link investigative work with the cases. In this workshop participants will see examples of how the original medical model of PBL has been modified and adapted for use in content rich biology classes. Illustrations will demonstrate how

PBL and case studies can be used to accomplish a variety of learning goals in biology. Participants will also engage with a case based on the Singapore Biology curriculum. They will do small group case analysis and question development as a way to make vivid the roles of teacher and learners. Discussion of implementation of cases/PBL will include assessment possibilities, ways to integrate case into classes (timing, for example), and preparing students for this way of learning.

Each participant will write a draft of a case and share that draft with others in the workshop as a way to introduce writing and editing techniques. Sources of already developed cases and PBL modules, freely available online, will be shared.

<Oral presentations>

**Action Research: Do Structured-Peer-Interactions and Q&A-Pool-Generation by Students Increase Students' Understanding of Biological Concepts?**

**Ashikin Abu Bakar**  
*Ngee Ann School, Singapore*

The study aims to discuss possible framework and strategies for knowledge building in students and how its effective implementation can sustain interest in the learning of Biology. The purpose of the research is to help students with low test scores gain higher levels of understanding and confidence in biological concepts through generation of a pool of questions and answers (Q&A) that they create as they read any given resource materials as well as to actively involve them in their own learning through structured peer interactions.

The interactions consist of a series of actions that the students carry out to guide their discussions. Another purpose is to ascertain the effectiveness of the instructional strategies and interventions put in place. This research involved two classes that showed, on average, a lower than expected

achievement results based on a software called PAMS. For each class, the students were divided into two groups based on their recent assessment results into the lower and higher ability groups. The lower ability groups were subjected to the strategies put in place while the control group was left to carry on with their own study techniques. These students were engaged in the tasks assigned for a two months period. The results showed an improvement in both students' understanding and confidence level in the biological concepts introduced to them with better retention of knowledge gained. At the same time, a positive correlation is also observed as the lower ability groups were able to perform on par with the higher ability groups in subsequent assessment.

**Keywords:** *Assessment for learning, constructivism theory*

**Exploring Alternative Conceptions and Conceptual Understanding of Tertiary Students in Global Warming through Constructivist-based Pedagogy**

**Supachai Basit**  
*Emilio Aguinaldo College, Philippines*

The issue of global warming has inadvertently created impacts on humanity, hence, educational awareness and possible interventions of any alternative concepts are necessary. This qualitative study investigates the alternative concepts of tertiary students on global warming by probing their knowledge representations through cognitive model reasoning test. During the intervention phase, students were allowed to watch a film clip on global warming and had a critical discourse analysis thereafter. Moreover, peer-to-peer learning was fostered by allowing the students to collaborate on group concept mapping on global warming. Post intervention findings indicate that a majority of the alternative concepts on global warming were corrected as shown by marked improvements of their cognitive models.

**Keywords:** *alternative conceptions, cognitive models, collaborative concept map, critical discourse analysis, global warming*

### **Effectiveness of Strategic Intervention Materials in Teaching Selected Topics in Biology**

**Gee Marie S. Binag**  
*Trento National High School/  
Bukidnon State University, Philippines*

The main purpose of this study was to determine the effectiveness of strategic intervention materials in the teaching of selected topics in biology among second year students of Trento National High School. The study aimed to answer the following questions: What is the profile of the students' achievement in Biology based on the pre-test and the post-test? Is there a significant difference between the pre-test and post-test both in the experimental and control groups? Is there a significant difference in the mean achievement score of students between the experimental and control groups?

The overall pre-test mean score of the experimental group was 16.04 with a standard deviation of 4.89, while the control group had 14.35 with a standard deviation of 3.03. The overall post-test mean score of the experimental group was 35.91 with a standard deviation of 5.43, while the control group had 32.26 with a standard deviation of 6.72. The difference in scores was in favor of the experimental group. This shows that the use of the Strategic Intervention Materials increased the performance of the biology learners in the test. Both the control and experimental groups made significant gain scores during the duration of the study. The following conclusions are drawn based on the above stated findings. The present mean score obtained by the experimental group was higher than the control group. The post-test mean score of the experimental group was comparatively higher than the control group. It is therefore concluded that

the use of the strategic intervention materials were helpful to them in the learning process. Students were able to do their best to answer the questions because the intervention activity was interesting and challenging.

### **Strengthening Science, Technology and Society Classes Using the “Wheel Illustration” as a Paradigm to Collegiate Biology Students of Far Eastern University-Manila**

**Benjamin Jr. Bolo, Myrna P. Quinto,  
Cynthia B. Mintu**  
*Far Eastern University, Philippines*

The “Wheel Illustration” was adapted from the Timothy Principle of Trotman (1989) to strengthen Science, Technology and Society (STS) classes among Biology students of Far Eastern University-Manila. The Wheel Illustration as a paradigm was used to explain the importance of individual person (Man) and its relevance to the concepts of Science, Technology and Society. The wheel has three major components: the hub, the spokes and the rim. The vertical dimension consisted of four spokes; Firstly, “Man-Spokes” which represents initial investigation that always begin with the idea of one man. Secondly, “Science-Spokes” which may rekindle man's idea to propel to conduct research through scientific method. Thirdly, Society-Spokes which mediate to recognize and implement research idea, findings of facts and knowledge. Finally, the Technology-Spokes which enhances the newly discovered facts or knowledge to be applied in the community. The first volitional dimension is the core or the Hub which holds the spokes together which represented by a Unified Delivery System (UDS). Man's idea along with STS has difficulty in achieving its functions and goals without UDS. On the other hand, a balance is created within the Rim of the wheel that would represent a successful implementation of the functions of STS.

## **Differentiated Instruction (DI) Lesson in Biology - Visit to Ecogarden**

**Peck Hoon Chng, Yvonne Lim**  
*Nan Hua High School, Singapore*

Differentiated Instruction (DI) lesson-Visit to the Eco-garden is developed to engage students in independent learning and to maximize teaching and learning. A pre-diagnostic test was carried out in a class where Secondary Four students were expected to use their pre-requisite knowledge and observational skills to deduce the general characteristic differences between insect-pollinated and wind-pollinated flowers and their advantages. The test was crafted to help to differentiate these students into 3 groups, the high-ability (HA), medium-ability (MA) and low-ability (LA). After the test was carried out, the three groups of students had their DI lesson on the topic, Reproduction in Plant carried out in the Eco-garden with different sets of worksheets. These worksheets were scaffolded according to readiness of students. The high-ability students' higher order thinking skills are built up in a step-by-step progress while the medium-ability and low-ability students were guided by the teachers to extend their understanding and skill levels. Through the observation of the lessons, the learning point is that DI lesson in the Eco-garden allows students to be self-directed learners and enable them to apply concepts learnt in textbook to real-life examples. Future studies will focus on how to improve the design on the worksheet to cater to each student's self-learning.

**Keywords:** *Differentiated Instruction, eco-garden, independent learning, self-directed learners*

## **Investigating Students' Use of Knowledge, Value and Personal Experiences (KVP) in Relation to the Different Attributes of Socioscientific Issues**

**Nina Christenson<sup>1</sup>, Shu-Nu Chang Rundgren<sup>2</sup>**  
<sup>1</sup>*Karlstad University, <sup>2</sup>Linköping University, Sweden*

The skills of argumentation have been emphasized

in science education during the past decades. But how much students could apply scientific knowledge to their informal argumentation is still unclear. This study aims to analyse 80 (40 science majors and 40 social science majors) Swedish upper secondary students' informal argumentation on four socioscientific issues (SSIs) including global warming, GMO, nuclear power and consumption. All the students were asked to express their opinions on one of the SSI topics they chose through written reports. Based upon the purpose of this study, the supporting reasons and the distribution of KVP students presented in their arguments were analyzed according to the SEE-SEP model with a holistic viewpoint covering the subject areas of sciences, economy, ethics, social/culture, environment and policy. The results showed that students used value to a large extent (67%) among the four SSI topics. The application of scientific knowledge was higher in the topics of nuclear power (32%) and GMO (31%), and personal experiences were used more in the topic of consumption (10%). Moreover, we found that the distribution of supporting reasons generated by students were different from different SSI topics. Also, some alternative concepts were disclosed in students' arguments. The implication to research and education are discussed.

**Keywords:** *Informal argumentation, science education, scientific knowledge, secondary school, socio-scientific issues*

## **An Assessment of the Pantabangan Reforestation, Livelihood, Health, and Spiritual Projects of La Consolacion College Manila**

**Rosalinda Mercedes E. Castillo**  
*La Consolacion College Manila, Philippines*

The La Consolacion College Manila Community Relations and Extension Services (CRES) assisted the people of West Poblacion, Pantabangan, Nueva Ecija by way of introducing and training the people

through the different livelihoods, health, and spiritual projects. The flagship project that was implemented in the community was to preserve their environment through the reforestation program. It is the desire of the school to identify the impact of the implemented programs on the beneficiaries, individually and the community in general. A survey was conducted to assess the impact of all the programs that were implemented. Through questionnaires, implementers and beneficiaries rated the implemented projects outstanding (4.44 and 4.42 out of 5.00, respectively). Some of the projects, though, were either not sustained or have not been started at all.

**Keywords:** *National Service Training Program, livelihood projects, Basic Ecclesial Communities, Citizen Welfare Training Service*

### **Research as an Integral Component of Biology Education in Philippine Schools**

**Josefino R. Castillo**

*University of Santo Tomas, Philippines*

Biology curriculum, in the past, has always been loaded with theoretical concepts leaving very little room for hands-on experience. Coupled with lack of laboratory equipment, students had to contend with demonstrations or worse, a diagram of the procedure of the experiment splashed with pictures of the equipment to be used. Recently, colleges and universities in the Philippines have placed a high premium on performance rating measured in terms of outputs in academic and professional organizations. Research has been integrated into the curriculum wherein undergraduate students are required to undertake experimental research under the supervision of a faculty member whose field of expertise is in line with the students' research, and present the same to a panel as a requirement for graduation. Most studies focus on testing medicinal plants against parasites, diabetes, hypertension, and cancer. Other fields of interest include allergy, immunology, molecular systematics, and

bioinformatics. Hampered by the lack of test animals, students resort to inducing diseased conditions in rodents, rabbits and birds. Another hindrance is posed by the Republic Act 8485, otherwise known as the "Animal Welfare Act of 1998" that limits the number of animals to six depriving the student – researcher of a statistically significant sample size.

**Keywords:** *Animal models, DNA sequence alignment, electrophoresis, PCR, PowerLab® research system*

### **Making a Difference for the Environment with the Green for Life Project at the De La Salle College of Saint Benilde**

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As part of their Environmental Chemistry and Ecology courses at the De La Salle-College of Saint Benilde, students are required to engage in activities that will make a difference in the environment. One such activity is their participation in the project called Green for LIFE: One Million Trees and Beyond. The goal of the project is to plant and nurture one million trees by the year 2011. As of June 2010, 720,710 trees have been planted by volunteers. After learning the basics of global warming, students plant mangrove seedlings by the beach to help reduce the amount of carbon dioxide, and thus, reduce global warming. Students also learn the ecological importance of mangroves and the importance of conservation of the mangrove ecosystem. Another project that our students do is energy and water conservation in their own households. At the beginning of the term, the students examine their electric or water consumption at home. They list down the activities of members of their household that use up electricity or water, and plan energy and water conservation measures, which they implement. To ensure that consumption will be decreased, the students also had to convince other members of their household to conserve electricity and water.

At the end of the term, the students present their electric or water bills before and after the project.

### **The Gap between the Curriculum and Teachers Knowledge of Suitable Development**

**Carola Borg, Niklas Gericke**  
*Karlstad University, Sweden*

The purpose of our study is to investigate upper secondary school teachers' understanding of the concept of sustainable development. A second aim is to find out if and how the understanding differs among teachers from different disciplines. We also look upon what challenges teachers from different disciplines face when implementing sustainable development in their teaching. Our goal is to identify opportunities for, and barriers to, education for sustainable development. The concept of sustainable development is complex, and previous research shows that teachers have difficulties in understanding the meaning of the concept. Because the Swedish curriculum states that every subject should include sustainable development issues, it is important to explore teachers' understanding of the concept and if it differs depending on which subjects they teach. To date, little information exists on how education for sustainable development is understood and taught by teachers representing all subject areas. Upper secondary school teachers (N=3229), from 223 schools in Sweden answered an online questionnaire with multiple choice question. The results show that many teachers lack a holistic perspective of the concept of sustainable development. Moreover, teachers' understanding of the concept seems to differ depending on which subject they teach. Teachers believe that the biggest difficulty in including sustainable development in their teaching is that the teachers themselves lack the necessary subject expertise and inspiring examples how to include sustainable development in their teaching.

Over 70% state that they have a desire for further education. The implications to research and education are discussed.

### **Designing and Field Testing of Remedial Material to Rectify Students' Misconceptions in Biology at the Secondary School Level**

**Narendra D. Deshmukh**  
*Homi Bhabha Centre for Science Education, TIFR, India*

A study was conducted to find out ideas of students from rural and urban areas about biological concepts such as respiration, reproduction, circulation, photosynthesis, nutrition and excretion. It is observed that students displayed an anthropocentric view and mechanistic view about these biological concepts. They understand the concepts of circulation, role of vitamins, a balanced diet but are confused with the concepts of respiration, functioning of heart, photosynthesis and role of nutrients. Students equated breathing with respiration, assumed the function of heart as the purification and formation of blood, and presumed vitamins as a source of energy. Rural students coming from vernacular medium believed that the heart hoards emotions and feelings and plants release oxygen only that supports living being. Study showed that misconceptions about respiration, vitamins, blood circulation and gas exchange etc. persist across grade levels.

Remedial material in biology was developed taking into account the nature of misconceptions and their sources. This material was tried in a sample of 37 rural and 62 urban students. The preliminary analysis of the data gathered shows that this material is useful for rectification of students' misconceptions. The paper presents the design of the study to understand misconceptions, method of developing remedial material and to field testing.

**Keywords:** *Biological concepts, misconceptions, remedial material*

## **Development of a Biology Laboratory Kit for Rural High Schools in the Philippines**

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<sup>2</sup>*MSU-Iligan Institute of Technology, Philippines*

A laboratory kit is designed and developed that contains teachers' guide and manual utilizing indigenous and recyclable materials which was tried out among rural High School Biology students of Gingoog City Division, Philippines. The aim of the kit was to uplift students' performance particularly in the achievement and development of scientific skills. The study comprised three phases, namely; Developmental Phase, Pilot Testing Phase, and Evaluation and Utilization Phase.

Results show that students with laboratory kit had improved achievement and had developed scientific skills compared to students without the kit. This study showed that as long as the biology teacher is innovative, there is no reason the teacher cannot do laboratory activities in biology classes. Likewise, facilities and equipment in a laboratory experiment can be innovated to suit to the learning needs of students to facilitate lifelong learning. It is recommended that the laboratory teaching kit be used in rural areas. Further study on the development of laboratory kit with indigenous and recyclable materials and testing of its effectiveness as a teaching tool in schools can help determine whether there is mastery of concepts that are tested in the National Achievement Test.

## **Disposable Diapers Decomposed by *Trichoderma harzianum* into Fertilizer for *Basella alba* as the Test Plant**

Jennifer Doromal

*La Filipina National High School, Philippines*

This study aimed to determine the capability of *Trichoderma harzianum* in the decomposition of used diapers and validate their potential as source of fertilizer to *Basella alba* plants. Disposable

diapers are not biodegradable in landfills and therefore contribute to environmental degradation globally. The research was laid out in a Randomized Complete Block Design (RCBD) with three treatments replicated three times using a total of 27 kg of used diapers or 3 kg per replicate in polyethylene bags. In Treatment 1 (T1), the diapers were mixed with 3 kg loam soil; T2 had 1 kg of bagasse with cultured *T. harzianum* and diapers; and T3 had 3 kg dried pig manure and diapers. These treatments were monitored for decomposition and the diapers (T2) were fully decomposed after 16 weeks. T2 had an average decomposition of 24 days against 100 days for T1 and 74 days for T3, which confirms that *T. harzianum* hastened the decomposition of the disposable diapers. After the sixteenth week, *B. alba* cuttings were planted on the same treatments with 75 g of loam soil added to T2 and T3. In addition, cuttings were also planted in a positive control of 75 g of loam soil with 5 g of ammonium sulfate. This is to determine whether T2 is more effective than the other treatments in promoting the growth of *B. alba*. The results indicated that there is no significant difference detected in the growth of the plant in T2 and the positive control. However, *B. alba* responded better to T2 than to T1 and T3.

**Keywords:** *Decomposition of waste, disposable diaper, environmental management, recycling*

## **Biology for Non-Majors at the University of the Philippines Diliman Extension Program in Pampanga (UPDEPP): Learning Sexually Transmitted Diseases Minus the Squirms**

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“Distinctly UP” was the pioneering program of the University of the Philippines Diliman called “Revitalized General Education Program” (RGEP) which was implemented in AY 2003-2004. In the

RGEP, students are allowed to choose freely from a menu of GE courses. It subsumed the General Education Program where offered courses have to be taken. When RGEP was implemented, Biology 1 – Contemporary Topics in Biology, was one of the new courses. Immediately, it turned out to become one of the favorites of students for a major topic is Reproduction and under it are the subtopics Reproductive Health and Sexually Transmitted Diseases (AIDS, Gonorrhea, Chlamydia, Syphilis, Genital Warts, etc.).

Given the current realities of UPDEPP, the offering of Biology 1 is very timely for two reasons: The unit is proximal to the night clubs and bars frequented by male foreigners and Filipinos alike, and the age bracket of the student takers at the junior level who are young and sexually aware, curious, will render knowledge that the course will impart most helpful and useful. The course is taught ordinarily with power point and video presentations with lecture and discussion where students' reactions to some lurid scenes were screams and squirms. There came a point when students "demanded" to take over some portions of the lessons, for variety's sake. And how they came up with original modes! Students regaled the class with 1) Mini-Theatrical Drama Presentations, 2) A hilariously funny pageant of Mr. and Miss STD, 3) Quiz Show: "What Am I?" 4) "Bring Me" Game and other concepts that students of vivid and wealthy imagination could cook up. Consequently, non-majors of Biology always find it a lively, refreshing diversion to take up Biology 1 to get educated with smiles and laughers, minus the squirms.

### **Outdoor Environmental Education and Sense of Place in Sydney-Teachers' View of Their Relationship**

**Emilia Fagerstam**  
*Linköping University, Sweden*

Today we live in a global world and an interesting

concern is what this means for our relation to local places where we live our daily life. In what way does schooling contribute to students' development of a sense of place? What role does encounters with nature play in environmental education/education for sustainability? This paper addresses how Environmental Education Centre (EEC) officers and science high school teachers in Sydney view the relationship between outdoor environmental education and students' development of a sense of place. Examining the EEC officers' and teachers' own associations with having a sense of place was also an objective of this study. Semi-structured interviews with thirteen EEC officers and eight science high school teachers revealed that sense of place can be viewed as familiarity with the local environment but also as part of a social-ecological system in a broader sense. Outdoor environmental education was considered important in many ways. Sydney is a multicultural society with immigrant students from all over the world and encounters with nature was regarded important as a way to increase Australian, and particularly immigrant students' understanding of the social-ecological systems they are part of. Fear for nature was common among students and encounters with nature were believed to install positive feelings for nature and to implement a responsible sustainable behaviour. A democratic aspect was the EECs contributions to give all students opportunity to experience natural as well as urban places of importance and in that way increase a sense of place for Sydney.

**Keywords:** *environmental education, nature experience, outdoor education, sense of place, sustainable education*

### **The Volant Mammals in Lowland Forest of Sierra Bullones, Bohol, Philippines**

**Lydia Jamora**  
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The study aimed to determine the diversity of bats

in Rajah Sikatuna Protected Landscape within Sierra Bullones, Bohol, Philippines. Two sampling stations, the agroecosystem and the forest ecosystem were established in each of the six sampling sites namely, barangays Nan-od, Canlangit, Casilay, Danicop, San Isidro, and Bugsoc that compose Rajah Sikatuna Protected Landscape. Bats were collected through mist nets and were identified. Habitat description adapted from Heaney *et al* (1998) and species composition were obtained. The diversity, relative abundance, species richness, evenness and endemism were computed and interpreted. Of the 17 bat species recorded, nine were fruit bats and eight, insect bats. The six barangays vary in species composition, diversity, species richness, evenness and relative abundance. *Cynopterus brachyotis*, a fruit bat, was common in the agroecosystem and forest ecosystem sampling stations of the six barangays. Except for barangay Bugsoc, it was relatively abundant in the agro-ecosystem of the rest of the barangays. *Rousettus amplexicaudatus* and *Eonycteris robusta*, in addition to *C. brachyotis*, were the common species in the agro-ecosystem sampling stations in all six barangays. In the forest ecosystem, *Ptenochirus jabori* was common to the six barangays. Species of insect bats were collected in the barangays except in barangay Danicop. Species richness was highest in the agro-ecosystem of barangay San Isidro and in the forest ecosystem of barangay Canlangit. Barangay Bugsoc, however, had the highest species richness when both agro-ecosystem and forest ecosystem sampling stations were treated as a whole. Lastly, barangay Bugsoc had the most diverse species of bats among the six barangays.

As for the relative abundance, it was barangay Bugsoc that had the highest relative abundance. Among the 17 species identified, six were endemic, two of which were insect bats. Barangays Canlangit and Danicop had the most even distribution of bat species in the agro-ecosystem and forest ecosystem sampling stations, respectively. In

considering both sampling stations, barangay Danicop had the most even or equitable distribution of bat species. Although, both barangays Bugsoc and Nan-od had an endemism of 40%, which is the highest value among all barangays, this result is still considered low. This is based on the percentage of collected bats in Sierra Bullones to the Philippine data (Heaney *et al.* 1987). The results suggest that some barangays can still support a variety of bat fauna while some need to be strictly regulated.

### **Creating a More Challenging and Active Biology Lesson: Helping Learners Get More Interested in and Enjoy Biology**

**Yoko Inoue**

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Recently science and technology have been progressing rapidly. The rapid advancements in science and technology may cause, in some cases, serious problems, when students lack interest in science. This trend is more prevalent in junior high schools than in elementary schools, and reportedly over 40% of Japanese high school students are said to have no interest in science and technology. Current students have few scientific experiences in nature when they are grown up. In addition, there are too many students, especially those who study biology, who think science is all about rote memorization of facts. Students thus lack the knowledge and experience associated with data analysis and the scientific process of hypothesis formation and clear and logical thinking.

It is difficult for teachers to lead the students to interesting experiments in class, which take more time and costs compared with lecture type classes. As a result, many teachers are unable to get students motivated in science. Also the curriculum is divided vertically, and the textbooks show no relationship with other branches of science. To make things better, I introduced biological experi-

ments and observations widely to encourage students to become more interested in science. In order to spread positive effects on many students in various high schools, I organized creative high school teacher learning and education programmes with funds of Ministry of Education and Science. The contents in this programme are as follows: (i) How to make learners enjoy learning and be more motivated in science, (ii) How to develop new ideas for the class, and (iii) How to build science presentation skills.

**Keywords:** education programmes, motivation, science presentation skills

### **Bats of Loboc Watershed Forest Reserve, Bohol, Philippines**

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The island of Bohol is one of the least biologically explored in the Philippines. Faunal explorations in the island are few as compared to other islands in the country. This study was aimed to taxonomically assess the flying mammals known as bats that are found in the six barangays of the Loboc watershed, Bohol. Mist netting was used to sample bat species in the various sampling sites. A total number of 15 species were recorded, namely: *Cynopterus brachyotis*, *Eonycteris spelaea*, *Haplonycteris fischeri*, *Ptenochirus jagori*, *Rousettus amplexicaudatus*, *Emballonura alecto*, *Megaderma spasma*, *Hipposideros diadema*, *H. obscurus*, *H. pygmaeus*, *Rhinolophus arcuatus*, *Rhinolophus rufus*, *Miniopterus australis*, *M. schreibersi*, and *Scotophilus kuhlii*. The most commonly caught and recorded in all sites was *C. brachyotis*. The Loboc watershed is known to be a secondary growth forest, hence, the abundance of this fruit bat is expected because this can tolerate disturbance. Despite of the disturbance, there were still endemic and nearly threatened species

recorded. The presence of these species in the sites surveyed is very encouraging and thus should be clearly taken into account for protection and conservation of the wildlife and their habitats. Furthermore, the social survey revealed limited knowledge about bats in their respective villages. Present threats to bat population coupled with disturbances in their habitats urgently call for conservation interventions.

### **Organisms Appearing in Elementary School Science Textbooks: Japanese and Korean Cases**

**Nobuyasu Katayama<sup>1</sup>, Yoon Lee<sup>2</sup>, Jaeyoung Kim<sup>2</sup>**

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Similarities in the science curricula between Japan and Korea have been frequently pointed out. The purpose of the present study was to clarify the similarities and differences in the contents of science textbooks. In Korea, there is only one series of science textbooks for elementary school students (Year 3 to Year 6) published by the government. On the other hand, there are 6 series of elementary science textbooks published by private publishers in Japan. So, we selected the leading one from among them for this study. The organism names appearing in these textbooks from both countries are mostly species names, but sometimes genus, family or order names. The number of the organism names in Korean textbooks is almost twice as large as that in Japanese textbooks. In both textbooks, most organisms are “higher” plants and animals: there are 2 protoctists, 2 fungi, 111 plants and 115 animals in Korean textbooks, and 7 protoctists, 1 lichen, 61 plants and 65 animals in Japanese textbooks.

**Keywords:** comparative study, elementary science textbook, Japan, Korea, organisms

## **Importance of Lecture Feedback in H2 Biology Lectures in a Junior College**

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Yen Ping Soh**

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Timely feedback is crucial in the effective teaching of GCE A Level Biology. In Singapore, junior colleges adopt the lecture-tutorial system in curriculum delivery. However, pedagogical effectiveness during lectures is hindered by many challenges that include large lecture size, diverse learning abilities of students and difficulty in monitoring students' learning. Hence, it is an uphill task to employ the best teaching practices that foster deep learning. We have administered post-lecture feedback for all Biology topics taught since 2007, and monitored the efficacy of this mode of student feedback on their understanding of biological concepts. Our qualitative findings, based on consolidated feedback from five student cohorts, have shown a positive correlation in the use of post-lecture feedback with students' ability to grasp concepts, and provided evidence that students improved in their capability to make connections between related themes in the subject. Students thus learn better and deeper when given timely and targeted feedback. The use of pre- and post-lecture tests, in which students from the "lecture feedback group" fared better compared to the control group, further substantiated our findings. There is a need to look into a less time-consuming and more efficient means of soliciting and collating feedback from large student numbers.

**Keywords:** *curriculum delivery, deep learning, diverse learning abilities, lecture-tutorial system, monitor students' learning*

## **Development of Meaningful Reception Learning in Japan**

**Shogo Kawakami**

*Gamagori Natural History Museum, Japan*

Meaningful reception learning is a learning theory

using advance organizers (AO) that emphasizes the deductive thinking process. AO is introduced prior to learning and it is a general and abstract concept that organizes the learning that follows. Our research group has clarified that charts and models can be used as AO. The key factor of introducing AO lies in creating an environment in which learners begin to question: I do not understand, Why does this happen? This type of questioning is called "create a cobweb" conditioning). Then advance organizers are inserted into such scenes. This paper is the summary of the AO that has been applied in our research up to now. AO is a technical term used in the research and it is sometimes expressed as a core perspective for on-coming learning. Similarly, meaningful reception learning is hereafter called simply reception learning. The effects of reception learning are the following: students understand, even those who are weak in science, understand; advanced learning can be introduced smoothly; children find science classes interesting because they understand. Reception learning cannot be replaced with discovery learning. Reception learning as well as discovery learning is included in problem-solving learning. Problem-solving learning can be enhanced by introducing reception learning. Reception learning is appropriate for learning abstract concepts. In that context, reception learning works well with many classes in junior high schools whereas discovery learning plays a pivotal role in elementary schools.

**Keywords:** *Advance organizer, discovery learning, meaningful reception learning, problem-solving learning, reception learning*

## **The Influence of Prompts on Students' Thinking Processes in Dinosaur Exhibits**

**Eunhee Kang, Jane Jiyoung Lee, Heui-Baik Kim**  
*Seoul National University, Korea*

The purpose of this study is to identify the influence of prompts for scientific reasoning on stu-

dents' thinking processes in dinosaur exhibits of Gwacheon National Science Museum. First of all, students visited the exhibitions without any prompts and asked to explain what they saw and what they understood. We, then, provided questions and cues as prompts related to the exhibits and asked to revise their explanations. Fourteen 3rd and 4th grade students participated in this study and explored the exhibits either alone or in a group. Dialogues between students and researchers were recorded, transcribed, and analyzed. Consequently, without prompts, students described only the information of the exhibits and their prior knowledge, and failed to link the exhibits, labels and their prior knowledge in making their explanations. On the other hand, when the questions or cues were given, they were able to connect the information on exhibits to their prior knowledge throughout inferential thought. Prompts functioned as cognitive support which facilitated students' reasoning by making students confirm and recall their prior knowledge, analogize using related knowledge, and consider various points of view through reflection. This additional supports are needed to complement the limitation of the exhibits and help students see the exhibits meaningfully in science museum.

**Keywords:** *cognitive support, informal learning, questioning, reasoning*

### **Sustainable Intensification of Agricultural Production: the Essential Role of Ecosystem-Literacy Education for Smallholder Farmers in Asia**

**Jan Willem Ketelaar, Alma Linda Abubakar**  
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Thailand*

FAO estimates that farmers will have to produce twice a much food as they do today as to feed the expected 9.2 billion global population by 2050. With declining availability of water and production land per caput, lower productivity, stress induced

by climate change and changing consumer patterns, farmers will have to intensify agricultural production. The challenge will be for them to do so sustainably. Inefficient use of agro-chemicals, both pesticides and fertilizers, remains prevalent among smallholder farmers in Asia. Vital ecosystem services provided by natural biological control and pollination are compromised as a result. Enduring and new concerns over farmer health, environmental pollution and food safety caused by indiscriminate use of agro-chemicals call for safer and more sustainable crop intensification and protection strategies. FAO has been working with Asian governments to develop robust Integrated Pest Management strategies (IPM) for a range of economically important crops during the last two decades. This paper will detail case studies of successfully employed IPM farmer education strategies, making optimal use of the innovative and adult-education- based Farmers Field Schools. The paper will make the case that it is of vital importance for achieving global food security that the millions of Asian farmers become ecology-literate and better managers through access to quality education. The paper will also highlight policy lessons learned, at national and global level, with regards to the pivotal role that farmer education plays for sustainable intensification of agricultural production.

### **Community Education for Agro-Biodiversity Conservation and Sustainable Utilization: Case Studies from the Asia region**

**Marut Jatiket, Jan Willem Ketelaar**  
*UN-FAO, Regional Office for Asia & Pacific,  
Thailand*

With the year 2010 proclaimed by the United Nations as International Year of Biodiversity, much attention and resources are focused on the need for conservation of biodiversity. With half of the global population still living in rural areas and de-

iving their livelihoods from agriculture, farmers are the custodians of vital ecosystem services provided by agro-biodiversity. Yet, international attention and allocation of resources for conservation and sustainable utilization of agro-biodiversity remains limited. Appreciation of agro-biodiversity fostered by quality education in rural communities is a pre-requisite for conservation and sustainable utilization. The regional NGO Field Alliance supports innovative agro-biodiversity education and mobilization work in rural communities in several Asian countries.

Communities develop and implement their own action plans for conservation and sustainable utilization of vital plant and/or animal species that are important for economic, livelihood, social or cultural reasons. This work also leads to curriculum reform and more attention to discovery-based education in rural formal education and vocational training. This paper and associated presentation will outline successful case studies of conservation and sustainable utilization of agro-diversity resources by local communities and make a case for more attention and resource allocation for agro-biodiversity rural education and community mobilization.

### **Students' Knowledge Integration and Decision Making: Learning from Collaboration During Environmental Field Study**

**Mijung Kim and Hoe Teck Tan**

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Environmental learning requires interdisciplinary approach and collaboration of various dimensions of sciences, technology, and society in order to enhance the sustainability of lifeworld. Science and technology has strived to understand and solve environmental changes and problems in local and global societies. However, its approach has been mechanistic and compartmentalized, thus, not ef-

fectively addressed the complexity of the current environmental issues. Recognizing this notion, there has been effort to bring into interdisciplinary knowledge and skills in environmental science education. This study attempts to enhance the opportunities of collective knowledge building and problem solving by designing collaboration among different research topics and levels of student grades. Sixteen 2nd year secondary students (age 14) and 16 junior college students (age 17) at Singapore public schools participated in environmental science field study to experience collective knowledge and decision making on building an ecological farm and village. Six different groups of students worked on different research topics to understand the characteristics of organic farm in Kahang region. They collected and analyzed samples in the field and shared findings each other. Their field work and discussion were video recorded and transcribed. The students' reflection notes were also collected. The data from video recording and students' reflection were coded and thematized. Throughout the study, students experienced and developed the understandings of integrated knowledge, difficulties and necessity of collaboration, and responsibility of knowing and decision making. Based on the findings, this study further discusses the development of leadership, implication of collaborative knowledge building and communication in science learning.

*Keywords: collaboration, environmental science, field study, knowledge integration*

### **Inculcating Environment Conservation in Si Ling Primary School**

**Jashanan Kasinathan, Christa Mei Ling**

**Tham-Chin, Hang Chuan Teng**

*Si Ling School, Singapore*

This paper presents the environmental education programme, Si Ling Conservation Curriculum (SLCC), undertaken by Si Ling Primary School. Previous research has shown that Singaporean stu-

dents hold a utilitarian view towards the environment and pay more attention to resource use rather than resource conservation. Acknowledging this trend, our school has designed an environmental programme to inculcate the love of nature amongst our students. The programme was first conceptualised and rolled out in 2008 and since then had undergone changes over the three years of implementation. In this paper, SLCC is discussed in four aspects, namely, its philosophy, its design, learning model and partnerships. The school has since collaborated with governmental organisation, (GOs), non-governmental organisations, (NGOs) and corporate partners towards achieving its goals. Future plan is in place, such as the setting up of a conservation room, a learning place for students and teachers to explore current environmental issues using hands-on approach. Finally, SLCC will be discussed upon previous research done on Singapore's environmental education landscape and suggestions to help improve schools with programmes.

**Keywords:** *life science, partnership, primary science, resource*

### **University Student Perceptions of Environmental Commons Dilemmas: The Need for Adjusted Curriculum Development in Indonesia**

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Factually subject to open-access conditions, many of Indonesia's forest resources are degraded by over-utilisation. For a more sustainable long-term development, socio-ecological 'commons dilemmas' – typical for open-access situations – need to be solved. This requires local actors possessing knowledge on social, economic, institutional, and ecological aspects of forest resource utilisation. Using qualitative interviews, we investigated

pre-concepts and perceptions that 19 future teachers and agricultural advisors – students of Universitas Tadulako, Palu/Central Sulawesi – bring to the management of the locally important non-timber forest resource rattan.

The results show that student pre-concepts were limited to – widely erroneous – ecological beliefs such as landslides or flooding allegedly effected by rattan overuse. Socio-economic impacts of overuse on rural livelihoods were not emphasised. The core of the commons dilemmas, i.e., the need to institutionally balance short-term individual exploitation with long-term and community interests in the preservation of a productive resource was not recognised at any detail.

Fostering the perception and cognitive competencies to analyse and – if possible – solve commons dilemmas should be a prime task of Education for Sustainable Development (ESD) globally. This task is particularly urgent in rural biodiversity 'hotspot' areas. While Indonesia strives to include ESD in its school curricula, our results show that future educators may lack the needed competencies themselves. In particular, socio-economic and institutional aspects of rural forest resource use need to be stressed in ESD including university curricula for future teachers and agricultural advisors. This may require revising teacher-centred teaching methods still predominant in Indonesia and much of Southeast Asia in general.

**Keywords:** *Common dilemmas, education for sustainable development, Indonesia, natural resources*

### **Exploring Middle School Students' Attitudinal Changes towards Science through Participation in Club Activities Making Science Magazine**

**Minjoo Lee and Heui-Baik Kim**  
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The interest and attitudes towards science are areas which need special attention in secondary science education in the perspective of student's subject

choice and career decision. With this rationale and based on an ethnographic perspective, this study was designed to explore how the learner's autonomous participation develops if they are provided with opportunities of various scientific practices and writings in the form of making science magazine as an extra-curricular club activities and what kinds of influence the participation have on the learners' attitudes and interest towards science. A qualitative research was conducted for 14 months and the participants were the instructor and fourteen 8th grade students who voluntarily took part in the club activities. Based on the activities such as observations of organisms around the school, scientific investigations of everyday life, and meetings with scientists, articles for the magazine have been written while students operate a web site. Data from participant observations, in-depth interviews with students, and documents were used to extract common characteristics of the practices. The learner's change was categorized into 3 stages in terms of participation in the learning community and science magazine clubs: peripheral participation, transitional participation and full participation. The findings of this study provide a deeper understanding of the factors that promote student's participation in science learning and suggest several implications of the influences that improved scientific attitude has on science learning.

**Keywords:** *Apprenticeship, attitude towards science, interest development, learning community, participation*

### **Linking Organic Farming with Biological Education in K-12 levels**

**Lee Yeung Chung**

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Organic farming has been promoted as an environmentally friendly agricultural method compared with the conventional method which involves the use of chemical fertilizers and pesticides. It is

also widely hailed as a means to make our environment more sustainable by reducing pollution and improving carbon sequestration. Although organic farming has been practised in some schools in Hong Kong as an extracurricular activity for promoting life-wide learning, it has seldom been linked seriously with the biology curriculum. This paper describes a project to bridge organic farming, secondary biological education and education for sustainability by using organic farming as a context for teaching and learning. The project is a three-stage one comprising: (i) the identification of opportunities in organic farming for learning biological concepts in different topical areas, (ii) the development of teaching and learning activities in the context of organic farming, and (iii) the dissemination of these activities to biology teachers. The project has the potential to incorporate at a later stage classroom research and evaluation of students' construction of biological concepts through active engagement in organic farming. The project is still on-going. This paper reports mainly on the outcomes of the first and second stage of its development and reflects on the opportunities and challenges arisen so far.

**Keywords:** *Education for sustainability, organic farming, secondary biological education, teaching and learning of biology*

### **Anatomical Characterization of Oil Cells and Oil Cavities in *Jatropha curcas* L. Using Light and Electron Microscopy**

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The country's effort on propagation of *Jatropha curcas* L. is a response to the call of the Department of Energy (DOE) to increase the use of alternative fuels as means to achieve its goal of "self-sufficiency in 2010" (Department of Energy Philippines 2006). In the same way, the Commission on Higher Education (CHED) includes the

intensive research on alternative energy source in the top list of its research agenda. Thus, the need to continually explore and intensify researches on alternative energy resources becomes imperative and poses an urgent challenge to scientists. This study on the anatomical characterization of oil secretory cells in the fruits and seeds of *J. curcas* is a pioneering attempt to contribute to the limited literature on the anatomy of oil secretory cell in plants. The study aims to identify the exact location of oil secretory structures in the tissues of the fruits and seeds. These structures are found both in the fruits and seeds at different stages of development. Sections were prepared using freehand technique and observed under light and electron microscopes. Test with Sudan IV and Sudan Black proves positive for oils. Oil cells are found in the middle-aged and mature seeds of *J. curcas*. While oil cavities are present in all ages of fruits and in the middle-aged and mature seeds. Generally, oil cell count is inversely proportional with the oil cavity count. The presence of oils secretory structures suggests significant contribution in the maximum use of the plant and yield of oil.

**Keywords:** *Alternative energy, freehand technique, secretory structure*

### **The Development and Evaluation of an Inquiry-Based Lesson on “Plant”**

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This study presents the development and evaluation of an inquiry-based lesson with backward design to enhance students learning on “Plants.” The researcher employed a quasi-experimental design to investigate the effects of the inquiry-based lesson. Two hundred and eighty five 5th grade students from six elementary schools at Kaohsiung City were selected as the subjects for this study. The students’ scores in “Attitudes toward Science,” “Meta-Cognition,” and “Concept Understanding on Plant..., ...” were collected and

analyzed through One-way ANCOVA. The findings showed that the experimental group students’ performance was significantly better on attitudes toward science ( $F(2) = 0.017$ ), meta-cognition ( $F(2)=0.074$ ), and concept understanding ( $F(2)=0.143, 0.188$ ) than the control group students. This study highlights the potential of using inquiry-based lesson with backward design as a means to help elementary students learn biology.

**Keywords:** *Curriculum development and evaluation, elementary student, inquiry, plant*

### **A Study of 1st Graders’ Science Learning on Biodiversity at Taipei Zoo**

**Ching-san Lai**

*National Taipei University of Education, Taiwan*

The United Nations declared 2010 the International Year of Biodiversity to celebrate life on earth and of the value of biodiversity for our lives. The study aims to integrate zoo resources and biodiversity issues into learning activities to promote students’ science learning and biodiversity understanding. There were 443 1st graders who participated in this study. Teaching activities include classroom discussion on the topics of animals and biodiversity issues, and a one day field trip to the Taipei zoo to enable students to gain insights on biodiversity. The results of the study are summarized as following: 96.6% of students were satisfied with the field trip to the Taipei zoo, 58.2% of students reported gaining a greater understanding on animals, 54.4% had a better understanding on biodiversity, and 55.8% of students indicated they were willing to visit to the Taipei zoo again in the near future. These results indicated that science teaching integrated with zoo resources and biodiversity issues had significantly influenced elementary school 1st graders interest in science.

**Keywords:** *Biodiversity, field trip, informal science learning, science education, zoo*

### **Improving Knowledge Generation, Critique and Justification among Graduate Students in a Zoological Sciences Course**

**Shirley S L Lim, Aik-Ling Tan, C H Diong**  
*National Institute of Education, Nanyang Technological University, Singapore*

This study examines how Asian students learn in a graduate course in zoological sciences. Set against the context of an Asian culture that still regards Confucius ideology of respect for teachers and not speaking against a teacher as important, university courses are consequently taught in an instructor-fronted and transmissive manner. This has resulted in low levels of students' participation, superficial understanding and critique of knowledge. Using Ford and Forman (2006) characterization of authentic science learning environment, a curriculum in a graduate seminar course was designed to include elements of reading, research, oral presentation and peer critique to increase knowledge claims, critique and justification by students. Using a self-reporting questionnaire at the end of the course, we found that reading and research is crucial for scientific knowledge forms the basis for conversations and critique. Students learn least through peer evaluation. This finding is indicative of (1) level of appreciation of the authentic practices as constructor and critiquer of claims; (2) students' confidence level in their level of knowledge to critique claims presented by peers; (3) students' ideas about the source of authoritative knowledge and (4) students' ability to break away from the dominant mentality of losing 'face' when speaking up. Further, students find oral presentation most difficult since this is not a common practice in the typical Singapore undergraduate curricula. These results suggest that more time needs to be allocated for reading and research as well as learning to make presentations and objective critique.

**Keywords:** *Graduate students, knowledge, zoological science*

### **Environmental Impacts on Stream Ecosystems and the Cold Spring in the Nong Hoi Sub-Watershed, Chiang Mai Province, Northern Thailand**

**Tidawan Mapiwong, Chitchol Phalaraksh, Somporn Chantara**  
*Chiang Mai University, Thailand*

The Cold Springs is a headwaters of the Nong Hoi sub-watershed of the Mae Sa watershed, which is a tributary of the Ping River in Chiang Mai Province. Monitoring of the water quality, major ions, pesticides and heavy metals was carried out to indicate possible pollution effects resulting from natural and human activities. The results of this research will help the protection and improvement of water quality in natural areas in the future. Water and macroinvertebrate samples were collected from 9 study sites within the Nong Hoi sub-watershed between August 2009 to July 2010. The physical and chemical parameters of the water including temperature, pH, conductivity, total dissolved solids, alkalinity, ammonia-nitrogen, nitrate-nitrogen, orthophosphates, dissolved oxygen and biochemical oxygen demand were determined. In comparison with the surface water quality standard of the Pollution Control Department in Thailand, water quality in the Nong Hoi sub-watershed was medium clean. Macroinvertebrates were assessed by using BMWP<sup>Thai</sup> score and ASPT was range from fairly good to fairly poor levels.

**Keywords:** *Cold spring, environmental impact, macroinvertebrates, stream ecosystem, water quality*

### **Extent of *Escherichia coli* Contamination of Cagayan de Oro River and Factors Causing Contamination**

**Lesley Lubos<sup>1</sup>, Lalevie C. Lubos<sup>2</sup>**

<sup>1</sup>*Liceo de Cagayan University,*  
<sup>2</sup>*Bukidnon State University, Philippines*

The study investigates the extent of fecal contamination of Cagayan de Oro River stretching along

the nine river barangays. Sampling sites covered the upstream, midstream, and downstream areas. The Multiple Tube Fermentation Technique (MTFT) was used to identify the presence of total coliform, fecal coliform, and *Escherichia coli* in the water samples. The average fecal coliform values obtained from all the sampling sites exceeded the acceptable value set by the Department of Environment and Natural Resources (DENR), indicating fecal contamination of the river water quality guidelines at 1000 fecal coliform organisms/100 ml. Bonbon had the highest level of fecal contamination while Dansolihon had the lowest level of contamination. The factors that might have contributed to the river's fecal contamination were improper disposal of human and animal wastes into the river due to the unavailability of toilet facilities. The study recommends that the University Clinic and the Office of Student Affairs issue policies, programs, and trainings of extension workers, faculty, and student volunteers in the river conservation project, to promote awareness and protection of people from *E. coli* contamination.

**Keywords:** *E. coli*, fecal contamination

## **Environmental Consciousness: A Global Responsibility**

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Environmental consciousness can be viewed as a child of the sixties in terms of its widespread recognition. Scholars have warned the detrimental effect of exponential population growth and rapid technological development on our environment. These and others warned that our very survival rested in achieving a sensitive balance between the considerable and mounting forces affecting the environment. The alarm was sounded based on dangerous levels of pollution in water, air, earth, and living things; major disturbances to the ecological balance: depletion of irreplaceable re-

sources; and tragic neglect of the man-made environment. It is therefore not surprising that people have gained a renewed perspective toward the use of resources taken from the environment. The United Nations recognized the need to concentrate on the education component of environmental awareness. It constituted the starting point of a new phase of interest where environmental education (EE) was seen as the centerpiece of all efforts that aim to effect change in the attitude and behavior of people toward the environment. It saw education as a lifelong process that needed to be provided at all levels, both in and out of school. The UNCED Conference in Rio de Janeiro endorsed sustainable development as part of the environmental education master plan. *Sustainable development* is defined a development that meets the needs of the present without compromising the ability of future generations to meet their own needs. To achieve sustainable development, citizens must develop decision-making strategies that would make sure that health needs, economic security, and environmental quality are maintained simultaneously. A new ethic was being sought through environmental education, from the individual to the international community. A key concept relates to the view that fostering responsible and effective participation concerning the quality of natural, social, and cultural environment is basic to improvement. To this end, education's role should center on the dissemination of information on development methods likely to maintain and enhance a harmonious relationship with the environment. In short, biology and its allies environmental education has to contribute to the advancement of knowledge and the acquisition of attitudes and skills required for the preservation and improvement of the quality of environment.

**Keywords:** *Environmental consciousness, environmental education, environmental quality, sustainable development*

## **Web-based Educational System Featuring SimRiver Software for Encouraging International Understanding of River Environment**

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The United Nations designated the safety and sanitation of water resources as one of its millennium goals and emphasized the role of international cooperative efforts in achieving this goal. Promoting a nation's awareness of river environments is one approach to this goal and science education has the potential to actualize it. Thus, we have developed "Diatom Project" multilingual web pages, which offer educational tools for understanding of relationship between human activities, river water quality and diatom communities for worldwide students. The educational system consist of three videos introducing what is diatom, "SimRiver" a multilingual simulator for river environment employing diatoms as bioindicators, a photo album showing variously polluted rivers in various ages, and a reporting system for student's opinions. Japan has taken the lead in the implementation of the lessons using this system from junior high school to university students, and recently the US had the lessons in middle schools. Korea also has a training course for secondary school teachers. Comparative analyses between the pre and post questionnaires for the lessons using the system indicate that the system was effective in promoting the awareness of the river environment. In the post survey conducted two weeks

later, the average score, which measures the awareness, increased two-fold after the lesson. The ratio of the university students, who showed interest in international understanding, was higher in the class of non-science major students (40.9%, n=44) than that of science major students (9.7%, n=144), suggesting the indispensable revisions in the lesson plans or the items in the questionnaire.

**Keywords:** Bioindicator, diatom, simulator, sustainable development, ubiquitous learning, water quality

## **Teaching Program for the Introduction to the Stem Cell Research**

Eri Mizumachi, Kei Kano  
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Recently, some researchers have suggested that stem cell biology should be taught in schools because, (i) stem cells represent scientific concepts in various fields of life science (i.e., developmental biology, genome science), and (ii) there is a need to communicate with the public in general and students about the issues related to stem cells research, such as regenerative medicine and ethics. Our group has developed a teaching program to introduce stem cell research. We call this program "iCeMS/CiRA Classroom: Hands-On with Stem Cells!" In this program, participants took a lecture on the introduction to stem cells, and then they develop hypothesis driven research proposals and experienced hands-on laboratory exercises. Through the program, participants were expected to acquire not only the knowledge "of" science on stem cells (i.e. stem cells can continuously divide, they can differentiate into tissues) but also the knowledge "about" science (i.e. advanced research on stem cells is progressing, scientific research is based on hypothesis testing). This program has been developed in collaboration with two young researchers in stem cells and some teachers in high schools. Young researchers have proposed a mission using stem cells: investigating whether ES cells are the same as iPS cells generated from the

skin cells. Teachers in high schools have given useful advice to improve the textbooks used in this program. This teacher-researcher collaboration was essential to the development of the program. In this presentation, we will give an overview of the program discuss the results of the study.

**Keywords:** *Educational program, knowledge about science, science communication, science knowledge, stem cell*

### **Biology Education in Undergraduate Students to be Elementary School Teacher at University**

**Koichi Morimoto**

*Nara University of Education, Japan*

This study reports lessons of biology education in freshmen and sophomores who are undergraduate students being trained to be elementary school teachers. The main contents related to biological science are, the names of popular plants, insect anatomy and the human body in elementary school biology. The contents related to teaching the biological concepts are, the development of lesson plans and explanations of plant form and function. The undergraduate students did not know much about popular plants in elementary science and they could not distinguish the head, thorax and abdomen in insects. Many students were hesitant to touch an insect larva. Some students could not illustrate the position of main human organs. The students have never written a lesson plan. In order to let the students acquire the biology contents and teaching methods, the instructor developed several teaching materials and revised his teaching approaches. The additional instructor activities included the dissection of chicken wings, the drawing of insects to illustrate its body parts, the observation of silkworm larvae, and the use of a T-shirts depicting the positions of the organs of the human body, and micro teaching. These instructor activities were found to be effective in enhancing learning of the biological contents and associ-

ated pedagogies among the undergraduate students. As a result, the students became interested in biology and they acquired the necessary teaching abilities.

**Keywords:** *Human body, insect, plant, teaching materials, undergraduate*

### **The Practice of the International Environmental Program, River Xchange Based on the Project WET between Japan and USA Elementary School**

**Kiyoyuki Oshika, Hiroko Nonoyama,  
Kazunari Sugawara**

*Aichi University of Education, Asahikawa River Nature Center, Foundation of River & Watershed Environment Management (Project WET JAPAN Secretariat), Japan*

In 2009, we carried out a River Xchange project as an International exchange program for an environmental study on rivers. River Xchange is a one-of-a-kind project that integrates environmental education topics with computer technology and international class partnerships so that students become “high tech pen pals” to learn about each other’s river ecosystems. In this program, each of two classes of 6th grade students in Asahikawa elementary school, Japan became to be partnered to a class of 4th grade students in New Mexico, U.S. Together, students learned about their local river ecosystems and posted what they learned (text, photos, and videos) on shared private wiki websites for 6 months. All students had implemented a variety of like activities from Project WET. Sometimes they invited guest speakers and lecturers to learn about river systems and ecosystems. Asahikawa students learned about the Ishikari River system and New Mexico student about the Rio-Grande River system. These rivers are very different from one another as are their surrounding environments. The students learned not just their own river system but that of their partner-class as well.

**Keywords:** *Ecosystem, international exchange, Project WET, river system*

### **Environmental Management for Social and Sustainable Development: Effective Strategies for Teaching the Disposal of Biodegradable Wastes in Primary and Secondary Schools**

**Zephernus C Njoku**

*University of Nigeria, Nigeria*

Human and other biotic activities result in the generation of enormous amount of wastes in the environment. Both urban and rural communities of nations experience various kinds of environmental pollution resulting mostly from human activities. Waste management is one of the very serious concerns of municipal administrators and community leaders. The problem of wastes has permeated both large urban, modest communities as well as villages. The nauseating stench of putrefying garbage and its ugly unsightly heaps littering urban landscapes not only destroy the aesthetic qualities of the environment, but also create niches for the breathing and spreading of many disease causing germs, most of which entail fatal consequences for humans and other useful members of the ecological community. Appropriate waste disposal is therefore critical to a sustainable well-being of humans and the environment. Appropriate knowledge, skills and attitudes towards waste generation and management is most effectively developed in children and youngsters at school. How shall we teach biodegradable environmental pollution so that youngsters develop the appropriate competencies and attitudes necessary for effective waste management? In this paper a brief review of biodegradable wastes was undertaken followed by descriptions and explanations of strategies which have proved effective in our Nigerian settings for teaching contents on biodegradable waste management in primary and secondary schools. More specifically the paper dealt with: What is biode-

gradable waste, why teach biodegradable wastes in primary and secondary schools, what social skills are developed by learners who have been taught using these strategies.

### **Biophysico-chemical and Socioeconomic Study of Two Major Manila Esteros**

**Glorina Orozco**

*Far Eastern University, Philippines*

Two major Manila esteros namely Estero de San Miguel and Estero de Quiapo, were studied to determine their ecological status. Physicochemical parameters of the esteros investigated were: turbidity, temperature, salinity, EC, pH, DO, BOD, COD, TKN, TP, Chl-a, and oil & grease. The results of analyses indicated that the recommended safe limits for the Class D water resources were all met. The TKN and TP values indicated hypertrophic conditions in all stations. Low Chl-a values were indicative of stressful conditions to the primary producers. Statistical analyses showed significant mean differences of most of the parameters per station and sampling season. Four species of fishes were found in the esteros, namely, *Rasbora maculata* (Kataba), *Gambusia affinis* (Mosquito Fish), *Anabas testudineus* (Climbing perch or Gurami) and *Hypostomus plecostomus* (Janitor fish), with *Rasbora* and *Gambusia* which exhibit resiliency and dominance in the two esteros. On the other hand, a total of 19 phytoplankton genera belonging to three algal groups were found thriving in the esteros, namely: Cyanophyta (3 spp.), Chlorophyta (9 spp.) and Bacillariophyta (7 spp.) Community indices of fishes and plankton showed high dominance in the plankton communities but low in evenness. Fish communities exhibited high evenness but low in dominance and diversity. Socioeconomic study revealed that attitude and actions of stakeholders to their esteros were influenced primarily by their economic status, educational and cultural background. Survey also

showed the awareness of the communities on the problems of esteros and their willingness to cooperate in the rehabilitation of their polluted canals. Institutional initiatives such as environmental education and community-based programs were looked into as possible key for the effective rehabilitation and attainment of sustainability of Manila esteros.

**Keywords:** *Biophysico-chemical, esteros, Manila City, socioeconomic study*

### **Metacognition as a Tool in Advancing Reading Comprehension in a Science Class**

**Jocelyn D. Partosa**

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Reading comprehension is a critical learning outcome and cuts across all content areas. Using metacognition as a tool, this study aimed at advancing reading comprehension among biology majors. In particular, the foci of the study were to recognize reading comprehension problems among biology majors; improve their reading processes and reading comprehension and promote metacognition among them. This study was conducted among 14 sophomore biology students enrolled in Plant Systematics. Students were given a total of three article reading assignments on separate occasions. The instrument was a reading survey adopted from Joseph (2006). The instrument was designed to gain information on students' reading comprehension problems, their reading behaviors and reading strategies. The reading comprehension problems are generally of cognitive and affective origin, with all 14 students pointing to inadequate vocabulary as their most challenging. Reading behaviors like preference for a particular reading position and reading aloud were crucial to comprehension for some students, just as writing questions and appreciating pictures in the article were contributory to comprehension. Students' reading strategies mostly involved consulting the

dictionary or the internet, rereading, note taking of important points or a combination of those strategies. Several students claimed that with metacognition they learned new ways on how to comprehend articles; even identifying factors that proved ineffective to comprehension were evident. Students also claimed to develop skills in monitoring their comprehension and correct misunderstandings. According to some students however, they need to improve their skills associated with making inferences, synthesizing information, and asking questions.

**Keywords:** *Comprehension problems, reading behaviors, reading log, reading strategies, reading survey*

### **DNA Doables: Hands-on Activities for Teaching Molecular Biology in the Secondary Level**

**Maria Elena Pinlac, Melanie Anne Cheng**

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Teaching molecular biology in the secondary level is a challenge, primarily because of the abstract nature of the concepts involved. To overcome this difficulty, teachers can use an approach that will cater to the different types of learners "visual, auditory, and kinesthetic" that comprise a typical class. This paper describes how five topics in molecular biology were illustrated through hands-on activities: (i) the search for the genetic material, (ii) the structure of the DNA molecule, (iii) the processes involved in the molecular dogma, (iv) DNA mutations, and (v) DNA sequencing. Each activity may be used separately after discussing each of the topics. Alternatively, all five activities may be conducted as a competition in which groups of 5-6 students each compete to finish all the stations within the least amount of time. Not only will this help teachers assess the students' understanding of the concepts, but it will also build camaraderie as well as a healthy level of competition within the class.

**Keywords:** *Molecular biology, student-centered activities*

### **Correlates of Achievement Test Performance in Biology 1 of Second Year Students in the Philippine Science High School, Central Entral Visayas Campus, Argao, Cebu from 2007-2010**

**Sherry Ramayla**

*Philippines Science High School - Central Visayas Campus, Philippines*

The principal aim of this study was to examine the different factors that might contribute to the achievement test performance of the Philippine Science High School - Central Visayas Campus students in Biology1. Key findings of this investigation showed that there is a substantial correlation between the grade and IQ of the students to the performance in achievement test. Other result showed that the teachers' experience, measured as the number of years of teaching the subject, and the educational background do not affect the achievement test result. There is no difference also on the achievement test results between students graduated in private and public elementary schools. This shows that student intrinsic factor plays an important role in the academic performance. However, it cannot be concluded that only such factor is accountable for the academic achievement of students because other multiple factors may explain achievement as well (Brophy 1974, Walberg 1974, Finn and Archiller 1990, McLaughlin and Drori 2000).

**Keywords:** *Achievement test, correlates*

### **Beliefs of Excellent Science Teachers**

**Myrna Quinto**

*Far Eastern University, Philippines*

The research study is mainly descriptive and qualitative. The research is a preliminary model/theory building based on Pandit's process of build-

ing grounded theory from case studies. Its main purpose is to describe, analyze, and categorize the beliefs of excellent science teachers. It involved science teachers who are consistent recipient of the Teaching Excellence Award in Biology, Chemistry and Physics from three participating schools, the Far Eastern University (Manila, Philippines), Central Luzon State University (Nueva, Ecija, Philippines), and La Consolacion College (Manila, Philippines). They were selected using purposive sampling. The multiple method of collecting data was used in the study namely, interview, classroom observation, and students' comments from their evaluation. These modes of collection (document, interview, observation) provide important data needed in this study. All data were analyzed. The study revealed the following results: Excellent science teachers believe that there are different approaches that generate learning; that science teachers should be conformists to standard and facilitators of learning; that excellent science teachers should provide meaningful leaning experiences and quality learning to students; and science teachers develop professionally by being an active learner a long term learner and reflective practitioner.

**Keywords:** *Beliefs, excellent science teachers, learning, teaching excellence*

### **Threshold Concepts: Challenging the Way We Think, Teach and Learn in Biology**

**Pauline M Ross<sup>1</sup>, Charlotte E Taylor<sup>2</sup>, Chris Hughes<sup>3</sup>, Noel Whitaker<sup>3</sup>, Louise Lutze-Mann<sup>3</sup>, Vicky Tzioumis<sup>2</sup>**

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Meyer and Land (2003, 2005) proposed the notion of 'threshold concepts;' concepts which are central to the mastery of a specific discipline that many students find difficult to learn and teachers find difficult to teach. Once understood, threshold concepts open a door within the discipline which is

akin to passing through a portal or conceptual gateway. These conceptual gateways or thresholds are characterised as being transformative, irreversible and integrative (Meyer and Land 2005). This transformed internal view is typified by a cognitive and ontological shift (Meyer, personal communication), often accompanied by an extension of the student's use language (Meyer and Land 2005). In Biology, as within other disciplines, there has been some debate about identifying threshold concepts as they are not necessarily equivalent with the traditional core curriculum content (Taylor 2006, 2007; Ross *et al.* 2007, 2010). Data from interviews conducted with 58 students and 11 academic staff from three universities and from an international survey of 55 academics were used to identify differences between novice and expert conceptions and assisted in the development of a matrix of threshold concepts in biology. Awe propose that these threshold concepts are not troublesome content areas; rather they are concepts which underpin difficult content areas including: energy and energy transformation, variation, probability and randomness, proportionality and surface area to volume ratio, dynamic equilibrium, linking the subcellular (submicroscopic) with the macroscopic, temporal and spatial scales (Ross *et al.* 2010, Table 1), and the formation and testing of hypotheses (Taylor and Meyer 2009).

**Keywords:** *Biology, learning, teaching, threshold concepts*

### **Development of a Social Constructivist Teaching and Learning Module on DNA for Thai High School Students**

**Thasaneeya Ratanaroutai**  
*Mahidol University, Thailand*

The purpose of this study was to develop a social constructivist teaching module on DNA for high school students. The first phase, genetics concepts and factors which affect teaching and learning genetics were studied. Then, a social con-

structivist teaching module on DNA was developed in the second phase. The data were collected from documents and interviews. Phase I-surveys on teaching and learning were completed by five high school biology teachers and thirty-one high school students in science program of four schools in Bangkok Education Service Area Office 1 who were volunteers for the interviews. The data were analyzed using descriptive statistics and content analysis. The results of this research showed that most teachers thought the whole genetics concepts for students' understanding were moderately difficult, which related to most students' answer. Both teachers and students group the concepts 'DNA Properties and DNA Synthesis' and 'DNA and RNA in Protein Synthesis' as difficult concepts for teaching and learning genetics. The teachers used explaining and questioning approaches with other teaching approaches, such as teacher demonstration and CA to teach the topics. Most of instructional materials were power-point slides. Students were assessed by tests. When the students had difficulties with learning, they would ask teachers, read additional books, and discussed with peers. Phase II- the DNA module was developed based on the social constructivist approach. The module include 'DNA Properties and DNA Synthesis,' 'DNA and RNA in Protein Synthesis,' and 'Chemical Structure of DNA' which are important topics.

**Keywords:** *DNA teaching and learning module, genetic concepts, high school students, social constructivist approach*

### **Cultural Comparison of Scientific Literacy in Media (SLiM) - From the Perspective of Biology Subject**

**Shu-Nu Chang Rundgren<sup>1</sup>, Carl-Johan Rundgren<sup>1</sup>, Chun-Yen Chang<sup>2</sup>, Yuen-Hsien Tseng<sup>2</sup>**

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Textbooks are the central resource of knowledge

for students in school education, but after school, newspapers become one of the main sources. To embrace scientific terms from both of these knowledge resources, an instrument to assess scientific literacy in media (SLiM) was developed by mapping scientific terms from Taiwanese news media and junior high science textbooks. The SLiM instrument includes 50 multiple-choice items covering the subjects of biology, earth science, physics and chemistry. This research aims to study whether students' SLiM performance has cultural differences through testing 22 biological items of SLiM in Sweden. A total of 117 Swedish students (81 females and 36 males) were invited to join the study, covering senior high students (10th-12th graders, N=64), and university undergraduates (N=53) with the same background of combined science/social science program. The results showed that undergraduates performed better than senior high students on the SLiM biology test with significant difference ( $p < 0.01$ ). However, it is interesting to discover that the 12th graders outperformed undergraduates. In terms of gender perspective, the female students performed better than male students in the study, but no significant difference was found. The 10th graders performed better than undergraduates in Taiwan. This was not found in Swedish data. From the perspective of the rate of correct answer of each item, the results indicated that the items related to daily life context or molecular sciences were more difficult for students in both Taiwan and Sweden. More discussion and implications to teaching and research will be presented.

**Keywords:** *Assessment, biology, culture study, media, scientific literacy*

### **Study of the Evaluation of Education of Biology in Active Learning**

**Kazutoshi Tamura**

*Niigata Municipal Bandai Senior High School, Japan*  
Biological materials are good subjects for active

learning or inquirer-based learning compared to the other science disciplines. In our biological education, new methods and ideas of evaluation about active learning have been developed. The Rubric method is ordinary and valid evaluation in active learning. However, this method is not easy to use in practice for ordinary school learning. We develop the practical method of evaluation about active learning in the case of biological education. In active learning, it is important for students to obtain the soluble problems in the science room or in the field. However, the teacher who is solely in charge of the class may be constrained in his knowledge and ability about some aspects of the learning contents. The new evaluation of the processes of active learning in biology education is to observe the student's work from a new angle, such as ascertaining learning difficulties and problems. In this way, we have obtained the perspectives to soluble processes of the problems. In the last stage of active learning, the students write a short paper. The papers were evaluated to assess whether the scientific logic is present or not in the student's work and not on performance at a particular grade level. This view of evaluation is very important. Some case studies are proposed for future studies of evaluation in biology education.

**Keywords:** *Practical method, problem-solving, scientific logic, senior high school students*

### **Behind the Scenes Account of the Science Storybook Project: Weaving Stories to Communicate Science**

**Frederick T. Talaue**

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Philippines*

It has been argued that a narrative-based pedagogy can potentially mediate the existing gulf between scientific (abstract, formal, decontextualised) and non-scientific (accessible, everyday, context-laden) language used in school science. With this ap-

proach, students do not only learn science through stories, they also learn to communicate scientific ideas through narrative construction. This paper presents the development and implementation of a project-based teaching unit on the topic “Popular Science and Children’s Literature.” Senior high school students enrolled in a Biology elective class assumed the role of story constructors and were tasked in groups to create a short storybook for children aged 4–7 years old. The storybook must exemplify a biology concept and capture the Philippine context. Students were engaged in a series of activities, including an inventory of locally published science storybooks, workshop on writing fiction/non-fiction for children, storyline conceptualization, peer critiquing, storybook production, storytelling in an outreach program, and learning reflection. A narrative-centred, constructivist learning environment was set up where students also had the opportunity to integrate skills in computer technology. More than contributing to the growing local pool of science-themed storybooks, the experience afforded the students an opportunity to explore a creative and relevant alternative mode for communicating science.

**Keywords:** *Constructivism, narrative-based pedagogy, science discourse, science literacy education, technology integration*

### **Empowering Biology Teachers through Development of Content and Pedagogical Content Knowledge**

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This research study is concerned with building capacity of biology teachers through development of their content and pedagogical content knowledge (PCK). The aims of this study were to (i) ascertain the knowledge base of biology teachers through exploring their current pedagogical content knowledge and identifying components that make up their pedagogical content knowledge, (ii) ex-

plore the effectiveness of a professional development training program on developing the PCK of these participating biology teachers, and (iii) develop a mechanism by which biology teachers’ content and pedagogical content knowledge are assessed and documented. The sample of the study consisted of 22 biology teachers of different professional backgrounds and teaching experience. The participating biology teachers were engaged in a series of professional development activities to impact their PCK and subjected to various classroom observations as well as collaborative and reflective activities to document their practice. The collected quantitative and qualitative data from these activities were categorized and analyzed. The findings of this study suggest that the participating biology teachers exhibit varied levels of content representation, varied level of PCK, and varied components that make up their PCK, indicating that teachers follow different pathways towards acquiring meaningful content representation. Furthermore, the series of the professional development activities implemented at the beginning of the research have impacted their content as well as their pedagogical content knowledge. The findings further suggest that teachers’ PCK can systematically be assessed and documented using the approach adopted in this research. Implications and future research are discussed.

**Keywords:** *PCK, teacher knowledge, teacher professional development*

### **Learning Experiences on Sustainable Development**

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The total learning experience of each student is a combination of different learning areas in the formal academic curriculum as well as the various programmes in the non-formal extra-curricular programmes. The roles played by civil society

and external organisations in complementing Singapore schools' formal academic and extra-curricular programmes in developing a sense of responsibility towards ensuring environmental sustainability are described. Some considerations for establishing and refining programmes for educating students on sustainable development are discussed. These programmes are needed to ensure that students' initial encounters with environmental issues will serve as sources of inspiration or challenges to the inner voices within themselves which will develop over time into passionate commitment.

**Keywords:** *Formal academic curriculum, non-formal extra-curricular programmes*

### **Students' Use of Terms and Conceptual Understanding in Making Meaning of Visualizations of Protein Function**

**Carl-Johan Rundgren, Richard Hirsch,  
Lena A. E. Tibell, Shu-Nu Chang Rundgren**  
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Molecular life science has become one of the fastest-growing fields regarding scientific and technical innovation. Images, diagrams and other forms of visualizations are playing increasingly important roles in molecular life science research, teaching and learning. This study examines how upper secondary students interpret visualizations of protein function. Thirteen upper secondary students and four tertiary students (majoring in biochemistry) were interviewed in semi-structured interviews. The interviews were structured around two 2D illustrations of proteins and an animated representation of water molecules being transported through a channel in the cell membrane. In the analysis of the transcripts, a score, based on the SOLO-taxonomy, was developed to evaluate the depth of students' conceptual understanding. Furthermore, the relative use of scientific terms, metaphors, deictic and non-conventionalized expressions in the students' explanations was also disclosed.

The results indicate that the beginner students frequently use metaphors which came from their school education or created by themselves, i.e. spontaneous metaphors. Students also make use of non-conventionalized expressions that seemingly have no meaning in relation to scientific concepts and processes. The results from this study indicated that there was no simple positive correlation between use of scientific terms and the depth of conceptual understanding. Interestingly, in the interviews, non-conventionalized expressions were used to express conceptual understanding and they play a role in the meaning-making of the students. Moreover, the results revealed that difficulties in science education may to a large degree be connected to the potential problems concerning communicating the precise and general nature of scientific terms.

**Keywords:** *Metaphors, molecular life science, non-conventionalized expressions, protein function, scientific terms*

### **Improving Science Learning through Writing Claim and Evidence**

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Ashri B Shukri**  
*Si Ling School, Singapore*

This paper draws on an exploratory action research into the use of (claim and evidence) writing-to-learn strategy in the teaching of human circulatory system and cell system. This study seeks to qualify and quantify the effects of using writing-to-learn science for a lower and middle group of students. Specifically, the research describes and interprets how writing claims and evidence statements can support learning of science concepts and ideas. Interviews with teachers were conducted on how they implement the writing strategy and challenges faced. Students' understanding and writing of the human circulatory system and cell system was described by teachers in three categories, namely, knowing what to include,

knowing what to exclude and how to organize claim and evidence in their writing. Pre- and post-tests were conducted to assess students' performance in topics taught and application of writing strategy. The study concludes that young students can develop complex understanding using claim and evidence writing-to-learn science method. The opportunities depended mainly on the rhetoric and writing structures used by the teachers, such as metaphors, real-life examples and pointing out critical aspects of the object of learning. The study has implications for the relationship between writing-to-learn science and students' learning of life science topics.

**Keywords:** *Claim and evidence, life science, primary science, writing to learn*

### **Computational Model for Caspase-3 Activation in Apoptosis Pathway**

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System biology is not the biology of system. Instead, it is the region between individual components and the system, and refers to those new properties that arise when you go from the molecule to the system. It is different from physiology or holism, which study the entire system. It is different from reductionist things like molecular biology, which only studies the molecules. With the progress of genome sequence project and range of other molecular biology project that accumulate in-depth knowledge of molecular nature of biological system, we are now at the stage to seriously look into possible of system-level understanding solidly grounded on molecular-level understanding.

Sensitivity analysis of XIAP using our computer simulation model demonstrates that Caspase-3 activation is not linearly dependent on XIAP expression level. Such non linearity can explain why the results of overexpression of a molecule are not

necessarily opposite to those observed when a molecule is under expressed. Similar asymmetric sensitivity is observed with many other molecules, such as Bcl-2, FLIP, Bid, APAF, and bi-directional sensitivity was observed in case of Caspase-8, Caspase-9, Fas, FasL, Smac and Bax. The results of simulation studies in the cases of XIAP, Bcl-2, FLIP, APAF, Caspase-8 and Caspase-9 correlate with those of experimentally validated results of Hua *et al.* This determines the accuracy of our computational model.

Simulation study was also performed on Bid molecules in our model. The amount of active Caspase-8 generated following FasL stimulation determines Type 1, Type 2 dominancy. In our model, we increased formation of Caspase-8 to 120 fold the baseline value while keeping other parameters unchanged. This leads to faster Caspase-3 activation. In addition Caspase-3 activation in our model becomes less sensitive to a 100 fold increase in Bcl2, which is phenotype of Type 1 pathway. However, increasing concentration of Bid up to 100 fold leads to slower activation of Caspase-3.

We infer that increasing the concentration of Bid, more amount of Bid will bind to Caspase-8 and more tBid is generated. Binding of Caspase-8 to Bid leads to Type 2 pathway activation which has slow kinetics of Caspase-3 activation due to cascade of reaction involved in the Type 2 pathway. However Type 1 pathway there is direct activation of Caspase-3 by Caspase-8, therefore leading to faster kinetics of Caspase-3 activation. However these results are contradictory to those reported by Hau *et al.* This may be due to complexity of our model. Since of the model of Hau *et al.* does not take Caspase-3-mediated feedback cleavage into account. This may be possible reason for contradictory effect.

In case of Smac, Bax, Fas, FasL sensitivity was observed in both direction up to certain level increase in concentration and up to certain level decrease in Fas concentration. This observation

suggests that there are certain threshold value up to which Caspase-3 can be activated and above that value activation of Caspase-3 become insensitive.

**Keywords:** DNA teaching and learning module, genetic concepts, high school students, social constructivist approach

### **Integrating in the Tertiary Level Syllabi - “An Awareness of Oil Producing Plants as Alternative Source of Energy for Sustainable Development”**

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The Philippines is endowed with plants of high economic values, most importantly oil producing plants, which can be alternative sources of renewable energy. In these times of oil crisis which the world is experiencing, it is but timely that the inclusion of these plants in the course syllabi of undergraduate and graduate student projects and theses is a must. Teaching within the framework of “Student -Centered Learning”, is a system of instruction that places the student in its heart. It is a teaching that facilitates active participation and independent inquiry that seeks to instill among students the joy of learning inside and outside of the classroom. One strategy that can contribute to the delivery of the student-centered learning is to encourage students to engage in independent research, as in thesis, which could involve an original investigation of a problem, the application of an appropriate methodology, and the interpretation and write-up of results (Ang *et al.* 2001). As an output, a written research paper is submitted and an oral presentation is presented by the students and graded separately. For my research work and undergraduate theses topics, five species were selected for the identification, distribution and anatomical characterization of oil cells. These plants are the following: *Pittosporum resiniferum* Hemsl., *Jatropha curcas* L. *Calophyllum inophyllum*, *Pon-*

*gamia pinnata*, and *Moringa oleifera*. Knowing the location of oil cells in the plant, distribution, frequency and anatomy, may lead to cost efficient extraction of oils, and the isolation of intact oil cells, which is highly valuable for self-sustainability.

**Keywords:** Anatomy, ecology, oil cells, student-centered learning, syllabi

### **Determining Students Water Allocation Preferences: A Vision for the Future**

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Australia is a dry continent and water allocation decisions are challenging. Effective water management requires an understanding of the conflicting demands for water and the likely results of the various water allocation decisions that can be made. University students of today will be the decision makers of the future, so it is vitally important that some components of University curricula include exercises in experiential learning. Here we present an educational tool that provides an example of a ‘hands on’ approach that can enhance learning and allow students to experiment with some hypothetical decision making with regard to the scarcity and vulnerability of water supplies. In addition the use of this tool provides students with an opportunity to increase their understanding of how the decisions they make an impact on the social, economic and environmental condition of the water basin and its communities.

Using a before and after questionnaire together with a visualisation tool called WINDSCREEN, this research sets out to investigate student’s views on environmental issues, with particular regard to 1) availability of water resources; 2) their preferences for water allocation and 3) whether using a visualisation tool added to the learning experience. It was found that students enrolled in environmental science show strong preferences toward

water allocation for environmental purposes and least preference toward water allocation for social purposes such as recreation.

**Keywords:** *Australia, environmental values, post compulsory education students, visualization, water resources*

### **Change of Pupils' Attitude towards Sustainable Preservation of Nature: Project-oriented Biology Lessons Including Outdoor Activities Foster a Nature Preservation Attitude in Pupils**

**Astrid Wasmann-Frahm**  
*Klaus-Groth Schule, Denmark*

This paper investigates the development of pupils' attitude towards nature preservation in a project-oriented learning approach. The theoretical framework relies on the theory of developing attitude toward conservation (Bögeholz 1999, Bogner 2007, Bogner 2004). Janßen and Köhler state that the development of environmental values takes place as an individual internal process (Janßen 1988, Köhler 1991) during outdoor action-oriented learning. It is hypothesised that opening science lessons towards hands-on-activities outside the classroom fosters a change of attitude towards nature in pupils. This study analyses an intervention of a soil project in integrated science (12 lessons). Outdoor learning activities in a school woodland (a small piece of woodland close to the school and owned by the school) was included. The focus was on acquiring biological, chemical and physical soil related knowledge, but an explicit soil-related nature problem was not issue of that education unit. The sample comprised 170 sixth graders. For a quantitative evaluation I developed a pupils' centered questionnaire and an open-ended problem solving task. A pre-, post- and follow up-test design was performed. The results show that students adopted a more positive attitude to nature conservation. The coming out of the problem solving task was for nature related arguments, a

statistically significant shift in direction of nature conservation while other arguments such as esthetics did not show an important change. The results of this study suggest that classroom teaching should be open to more outdoor science activities during regular science lessons.

**Keywords:** *Change of attitude, nature, outdoor activities, project-oriented learning*

### **The Effect of Taiwanese Citizens' Biotechnology Knowledge and World-views on Attitudes toward Biotechnology Related Issues**

**Kun-Chang Wu<sup>1</sup>, Tai-Chu Huang<sup>1</sup>,  
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Hong-Lin Chiu<sup>1</sup>, Chia-Ju Liu<sup>1</sup>, Jeng-Fung Hung<sup>1</sup>,  
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Modern biotechnology has a large impact on society, and researchers and policy-makers need the public's monitoring and feedback on such impact. The aim of this study is to understand the current attitudes of adult citizens in Taiwan toward biotechnology related issues and how these attitudes have been affected by such factors as gender, age, biotechnology knowledge, and their personal "worldview." A survey was conducted among a sample of 4,448 citizens ages 18 and over by probability proportion, and a total of 2,024 valid questionnaires were received. Results showed, (i) the use of genetically-modified foods were favored more among males than females ( $\chi^2=33.52$ ,  $p<.001$ ). When analyzed by age, citizens under the age of 29 and over the age of 60 were more willing to accept these kinds of foods than citizens between the ages of 30 to 59 ( $\chi^2=63.02$ ,  $p<.001$ ); (ii) Similar results were also obtained among citizens' attitudes toward animal cloning (gender  $\chi^2=12.98$ ,  $p<.01$ ; age  $\chi^2=30.20$ ,  $p<.001$ ); (iii) No statistically significant difference was detected between males and females participants regarding prenatal genetic screening; (iv) Predictive factors

such as supporting scientific development, optimism toward the use of technology, pseudoscience views, biotechnology knowledge, gender, and age are all positively related to the dependent variable of “attitudes toward biotechnology.” The highest positive correlation was between the reservation of technology and attitudes ( $r=.48$ ); (v) Regression analysis revealed the worldviews of citizens had the most significant impact on attitudes toward biotechnology which were followed by knowledge and gender. Finally, this study offers some suggestions for improving citizens’ attitudes toward biotechnology for future research.

**Keywords:** *Biotechnology knowledge, citizens worldviews, multiple hierarchical regression analysis*

### **Working with the Experts: Enhancing High School Biology Learning through Internship Programs**

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Advocates of contextual learning claim that students learn better when provided with practical connections between schoolwork and the real world of home, work, and community (e.g. Gaskell and Tsai 2000, Hurd 1998). Educators further argue that contextual learning through work-related, inquiry-based experiences helps develop communication, collaboration, critical thinking, and problem-solving skills deemed important for students’ future roles and responsibilities in society. This study explored these claims by documenting Filipino learners’ experiences in an internship program that seeks to develop students’ science research, and lifelong learning skills by engaging them in the real-life contexts of a scientist’s or an engineer’s work.

The context for this study is a summer science internship program where students become involved in the real-life projects of scientists in research institutions in the Philippines. The program aims to

enhance student-interns’ interest and future participation in science courses and careers. I examined students’ experiences in the internship through the conduct of surveys, and the examination of student portfolio/journal. This paper describes components of the internship program that were effective in developing students’ practical skills, work-related knowledge, and improved attitudes and behaviors. Findings from the study provide valuable insights into how school biology curriculum can be designed to help equip students with critical thinking and lifelong learning skills that are vital for their future roles as science leaders and workers in the 21st century.

**Keywords:** *Contextual learning, internship, summer program, work-oriented learning*

<Poster presentations>

### **Spectrophotometric Determination of Phalloidin and $\alpha$ -Amanitin in *Amanita* Mushrooms**

**Butkrachang, S.<sup>1</sup>, Sardud, U.<sup>2</sup>, Narongchai, P.<sup>2</sup>**  
<sup>1</sup>*Rajamangala University of Technology,*  
<sup>2</sup>*Chiang Mai University, Thailand*

A simple and sensitive spectrophotometric method has been developed for the determination of standard phalloidin and  $\alpha$ -amanitin in extraction medium [methanol:water:0.1 M HCl, 5:4:1, v/v/v]. The proposed method is based upon the presence of standard phalloidin and  $\alpha$ -amanitin in extraction medium with an absorption maximum at 285 and 305 nm, respectively. The absorbance Beer’s Law of phalloidin and  $\alpha$ -amanitin over the range of 3 - 30 and 1 - 100 ppm, respectively. The proposed method was successfully applied to the analysis of *Amanita* mushrooms sample. The methods have the advantages of being simple, time saving and sensitive with a minimum detection limit (LOD) of 1 ppm.

**Keywords:**  *$\alpha$ -Amanitin, *Amanita* mushrooms, determination, phalloidin, spectrophotometry*

### **$\alpha$ -Amanitin and Phalloidin Content of *Amanita* Mushrooms in Nan Community Forests**

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*Amanita* mushrooms were surveyed and collected during May 2008 to August 2009 in Nan community forests (Pua, Na Muen, Chiang Klang, Chaloe Phra Kiat, Bo Kluea and Tha Wang Pha districts). For each study area, the experienced people were consulted through interviews and questionnaires related to the edible and poisonous *Amanita* mushrooms in Nan community forests. Based on the differences of morphological characteristics, there were fifty-one species of *Amanita* mushrooms. Of these, only four species were recognized as edible mushrooms by the locals, i.e. *Amanita caesarea*, *A. cheapangiana*, *A. hemibapha*, and *A. princeps*. Among these *Amanita* mushrooms, 70% were not known by the local people. Forty-two species of *Amanita* mushrooms were subsequently examined for the presence of  $\alpha$ -amanitin and phalloidin by thin layer chromatography and confirmed by high performance liquid chromatography.

**Keywords:**  *$\alpha$ -Amanitin content, *Amanita* mushrooms, Nan community forests*

### **Effects of *Annona squamosa* L. Leaf Extract on *Mus musculus* Exposed to Mercuric Acetate: Evaluation of Metal-Induced Oxidative Stress and Histopathology in the Brain and Liver**

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**Edna A. Amparado<sup>2)</sup>**

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Plants with potent antioxidant properties may also have the potential to counteract the effects of heavy metal-induced toxicity in the central nervous system and the liver. In this study, the protective

attenuation of the ethanolic leaf extracts from *Annona squamosa* (ELEAS) known for its antioxidant and antidiabetic properties was evaluated in the gestating mice subcutaneously treated with 4 mg/kg mercuric acetate (MA) and their resulting foetus exposed to the metal *in-utero*. Female ICR mice were treated with MA for three consecutive days starting GD 14-16. Effects of solo exposure of ELEAS at 25 mg/kg or simultaneous exposure of ELEAS at 25 mg/kg and 75 mg/kg with MA in the maternal and foetal subjects were evaluated at GD19. The lipid peroxidation assay reveal that ELEAS was only able protect the maternal liver against metal-induced oxidative stress but not those of the foetus as manifested in the lower MDA values of solo ELEAS and simultaneous exposure of MA and the two doses of ELEAS (<0.05). The results of this study suggest that ELEAS has the potential to protect against MA-induced oxidative stress in the maternal mice but not in gestating subjects. ELEAS enhanced the occurrence of histopathologic cells and morphometric aberrations in both maternal and foetal mice. The antioxidant protective mechanisms of ELEAS against metal induced toxicity and its toxicological implications therefore must be explored in future researches.

**Keywords:** *Annona squamosa, mercuric acetate, oxidative stress*

### **Disposable Diapers into Fertilizer for *Basella alba***

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This study aimed to determine the capability of *Trichoderma harzianum* in the decomposition of used diapers and validate their potential as source of fertilizer to *Basella alba* plants. Disposable diapers are not biodegradable in landfills and therefore contribute to environmental degradation globally. The research was laid out in a Randomized Complete Block Design (RCBD) with three treatments replicated three times using a total of 27

kg of used diapers or 3 kg per replicate in polyethylene bags. In Treatment 1 (T1), the diapers were mixed with 3 kg loam soil; T2 had 1 kg of bagasse with cultured *T. harzianum* and diapers; and T3 had 3 kg dried pig manure and diapers. These treatments were monitored for decomposition and the diapers (T2) were fully decomposed after sixteen weeks. T2 had an average decomposition of 24 days against 100 days for T1 and 74 days for T3, which confirms that *T. harzianum* hastened the decomposition of the disposable diapers. After the sixteenth week, *B. alba* cuttings were planted on the same treatments with 75 g of loam soil added to T2 and T3. In addition, cuttings were also planted in a positive control of 75 g of loam soil with 5 g of ammonium sulfate. This is to determine whether T2 is more effective than the other treatments in promoting the growth of *B. alba*. The results indicated that there is no significant difference detected in the growth of the plant in T2 and the positive control. However, *B. alba* responded better to T2 than to T1 and T3. Special assays confirmed that T2 contain essential nutrients and trace elements needed for plant growth and development.

**Keywords:** *Decomposition, diapers, environmental management, fertilizer, waste recycling*

### **Mutational Analysis of the Alzheimer's Disease Amyloid $\beta$ -peptide ( $A\beta$ ) Derivative $A\beta_{1-40}^*$ and its Cleavage by *E. coli* Pitrilysin**

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*Escherichia coli* pitrilysin (EC3.4.24.55) is a homologue of the human insulysin which has recently been found to degrade the amyloid  $\beta$ -protein ( $A\beta$ ) associated with the pathogenesis of the Alzheimer's disease (AD). To analyze the physiological and biochemical function of this enzyme,

mutant pitrilysin with substitutions on the active (Glu<sup>91</sup>) and/or metal-binding (Glu<sup>169</sup>) sites to Ala were constructed and found to be devoid of enzymatic activity. But the disruption of the *ptr* gene of the host strain by the chloramphenicol (*cat*) gene did not cause demonstrable phenotypic alteration except for slight reduction of growth rate.

To further elucidate the functional and structural mechanisms of substrate binding by this enzyme, a 40 amino acid residues  $A\beta$  derivative ( $A\beta_{1-40}^*$ ) was synthesized and cloned as a fusion protein with *E. coli* RNase HI. The  $A\beta_{1-40}^*$  exhibits higher amyloidogenic activity but was cleaved by pitrilysin at identical sites as the wild-type  $A\beta$ . Measurement of the far-UV CD spectra suggests that  $A\beta_{1-40}^*$  is conformationally similar to  $A\beta_{1-40}$ . The N-terminal truncated  $A\beta_{15-40}^*$  peptide formed reduced amyloid fibrils suggesting that cleavage of this enzyme predominantly at the His<sup>14</sup>-Gln<sup>15</sup> position decreases the amyloidogenicity of this peptide. The well preserved hydrophobic core (Leu<sup>17</sup>, Val<sup>18</sup>, Phe<sup>19</sup>) was demonstrated to be vital for amyloid formation because series of  $A\beta_{1-40}^*$  derivatives with collective or individual substitution of these amino acid residues to hydrophilic serine markedly inhibited amyloid formation as determined by the ThT binding assay. Meanwhile, substitutions to these amino acid residues to alanine slightly increased its ability to form amyloid fibrils *in vitro*.

**Keywords:** *Alzheimer's disease, E. coli pitrilysin, human insulysin*

### **Strengthening Science, Technology and Society Classes Using the "Wheel Illustration" as a Paradigm to Collegiate Biology Students of Far Eastern University-Manila**

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The "Wheel Illustration" was adapted from the Timothy Principle of Trotman (1989) to strengthen

Science, Technology and Society (STS) classes among Biology students of Far Eastern University-Manila. The Wheel Illustration as a paradigm was used to explain the importance of individual person (Man) and its relevance to the concepts of Science, Technology and Society. The wheel has three major components: the hub, the spokes and the rim. The vertical dimension consisted of four spokes; Firstly, "Man-Spokes" which represents initial investigation that always begin with the idea of one man. Secondly, "Science-Spokes" which may rekindle man's idea to propel to conduct research through scientific method. Thirdly, Society-Spokes which mediate to recognize and implement research idea, findings of facts and knowledge. Finally, the Technology-Spokes which enhances the newly discovered facts or knowledge to be applied in the community. The first volitional dimension is the core or the Hub which holds the spokes together which represented by a Unified Delivery System (UDS). Man's idea along with STS has difficulty in achieving its functions and goals without UDS. On the other hand, a balance is created within the Rim of the wheel that would represent a successful implementation of the functions of STS.

### **Effects of *Voacanga* sp. Leaf Crude Ethanol Extract on the Testicular Morphology of the Perinatal Bisphenol A-exposed Mice *Mus musculus* L.**

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The study was conducted to determine the effects of prenatal bisphenol A (BPA) and *Voacanga* sp. leaf extracts on the testicular morphology of male neonatal mice. Twenty four timed-pregnant mice were arranged in a randomly blocked design to six different treatment groups with four replicates. The first group (T1) was subcutaneously injected with an oil vehicle. The second group (T2) was

treated with 10  $\mu\text{g BPA kg-day}^{-1}$ . The third (T3) and the fourth (T4) groups were treated with 10  $\mu\text{g BPA kg-day}^{-1}$  + 500  $\mu\text{g kg}^{-1}$  *Voacanga* leaf extracts, and 10  $\mu\text{g kg-day}^{-1}$  BPA + 1000  $\mu\text{g kg-day}^{-1}$  *Voacanga* leaf extracts, respectively. The fifth (T5) group was treated with *Voacanga* extract at 1000  $\mu\text{g kg-day}^{-1}$ , and the sixth (T6) group was neither treated with BPA nor *Voacanga* for comparison. Histological sections of neonate testes were compared among treatments using light microscopy. BPA-treated mice (T2), and mice treated with Bisphenol A and *Voacanga* leaf extracts (T3 & T4) had less developed testes compared to the controls (T1 & T6) by having smaller testicles, smaller and less numerous seminiferous tubules, spermatogenic and Sertoli cells for each tubule. Mice treated with *Voacanga* extracts (T5) had less developed testes compared with the controls, but had more developed testes when compared to mice treated with BPA or BPA plus *Voacanga* leaf extracts. This shows that BPA affects testicular development of male neonatal mice indicating anti-androgenic effects. Furthermore, *Voacanga* leaf extracts did not alter BPA-related effects on the testes indicating absence of substances related to male reproductive physiology.

**Keywords:** *Estrogenic effects, plastics, seminiferous tubules, spermatogenic cells*

### **Scientific Argumentation at College Level: Developing a Teaching Strategy Based on Guided Literature Criticism**

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Argumentation is one of the core activities in science enterprise. Unfortunately, students usually do not have the opportunity to practice and elaborate this skill under the operation of current curriculum. College students majored in any science field will be very likely to develop a science-related career, thus the proficient in argumentation will greatly influence their professional

competence. This research therefore is focused on formulating the educational interventions to improve the scientific argumentation ability of college students. Students majored in life sciences field were chosen as the sample, and thus the life science related literatures were used as the example for argumentation development. We have set up the scaffold for science literature analysis and asked both graduate students and undergraduate students to perform argumentation analysis. An instructor-guided scientific literature presentation has been formulated as the assessment tool for scientific argumentation performance. We also developed a questionnaire to ask the students to do self-assessment for their progress in argumentation. In this report, we will present the following data: (i) the difficulties the students encountered when making scientific argumentation, (ii) the usefulness for the scaffold in helping students to identify the main assertions in the scientific literature, and (iii) an effective educational strategy to help the students in making scientific argumentation.

**Keywords:** *Critical thinking, literature presentation, science argumentation*

### **Collaboration of Science Education between Teachers in Elementary Schools and Instructors from University Using a Portable Scanning Electron Microscope**

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Japanese teachers in elementary schools are expected to take the initiative towards introducing outside educational resources into their classes, as the Japanese guideline of science study for teachers indicates that “Some considerations should be given to utilize museums and science centers actively by seeking partnership and cooperation with them” (Ministry of Education, Culture, Sports, Science and Technology). The Science & Education Center of Ochanomizu University has made a

partnership agreement with the board of education of Kita-city in Tokyo to conduct the collaborative science classes, in which we use a portable scanning electron microscope (SEM) to enhance children’s interest in science. In this study, we developed the support system for teachers in elementary schools to prepare samples for SEM, to operate SEM and to provide lesson plans adapting school curriculum.

**Keywords:** *Observation, partnership, promotion of S&T for children, science activity*

### **A Survey of Bats, Caves, and Cave Resource Use on Bohol Island, Philippines**

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Prior cave fauna inventories within the Rajah Sikatuna Protected Landscape (RSPL) on Bohol Island resulted in the documentation of bat species absent or rare in other, more thoroughly studied, regions of the Philippines. The absence of these species on other islands may reflect species specific requirements for large caves and lowland forest, resources present on Bohol Island and rare in other surveyed areas. In order to determine the conservation status of these cave-dwelling bats in Bohol, we surveyed bats and documented the disturbance of 14 caves within the RSPL, and 11 caves outside RSPL that were either developed or earmarked for ecotourism development. We assessed bat diversity through a combination of harp trap sampling in forests near caves, visual assessments of cave populations, and acoustic monitoring. Cave disturbance was assessed by recording physical signs (e.g. digging, fishing nets, graffiti, etc.) within each cave, and also through standardized community cave use surveys. We documented 28 bat species, including four poorly known species (*Hipposideros coronatus*, *Kerivoula*

c.f. *papillosa*, *K. pellucida*, and *Phoniscus jagorii*). Moreover, we recorded species associated with large caves, which are rare or absent in non-karst areas, such as *Hipposideros pygmaeus*, *Rhinolophus philippinensis* and *R. rufus*. Most of the caves visited were highly disturbed, and as a result, only 13 of the 25 caves visited had bats present. Cave-use surveys and physical evidence in caves revealed that small-scale guano collection for use in local rice fields was common within RSPL; however, swiftlet nest collecting and treasure hunting activities were also widespread.

### Development of Device to Raise Curiosity

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<sup>1</sup>Kyoto University, <sup>2</sup>The Kyoto University Museum, Japan

Scientific knowledge, according to PISA, refers to both knowledge of science and knowledge about science. Knowledge of science refers to knowledge of the natural world, and knowledge about science refers to knowledge of the means (scientific enquiry) and goals (scientific explanations) of science. High school teachers in Japan have emphasized knowledge of science more than knowledge about science to pass their students on the university examinations. To improve the balance between the knowledge of science and the knowledge about science, we have developed some educational programs for the introduction to scientific enquiry. One of these is the device to raise curiosity, which we call “iCeMS Connection” activity. Curiosity is the first step for scientific enquiry. In this activity, we asked scientists to use some educational tools such as a cotton candy machine, clays, blocks, puzzles, or microscopes to raise curiosity of high school students. We also asked them to follow the rules to draw out “whys” efficiently. 1) Attract and communicate with as many students as possible through your educational tools. 2) Do NOT teach anything until students ask you. 3) Enjoy yourself! We had five booths, whose

themes were different, in parallel on June 5, 2010. There were 700 interactions between scientists and participants. We recorded about a half of the interactions on video equipments and analyzed them from the viewpoint of the quantities and qualities of the whys scientists have drawn out. In this poster, we will show the results of the analysis.

**Keywords:** Educational program, knowledge science, science communication, scientific knowledge

### Curriculum in Science High Schools in Cavite, Philippines: An Assessment

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A study was conducted to evaluate the curricular program in science high schools in Cavite, Philippines as perceived by the students and faculty. Forty two faculty and 416 students served as respondents. Among the five participating schools, two offer full science curriculum across all year levels while three have special science classes for selected group of students. The student-respondents were mostly female and with ages ranging from 13 to 17. The faculty respondents were mostly married, female and with mean age of 42. The high school students perceived that their laboratory facilities are adequate for Mathematics and Physics, while adequate to very adequate for Biology, Chemistry and Computer. However, the faculty members had different views as to adequacy. The students also perceived the following: that their teachers are competent; that their subjects are challenging; and that the schools provide varied opportunities to hone their talents. Most of the students emphasized the confidence in going to college. In general, the students believed that their schools belong to the best schools in the country. Interviews with the teachers revealed that the schools have different organizational structures and different sets of policies to implement the science curriculum particularly with their admission and retention policies.

**Keywords:** *Biology, curriculum, laboratory, perception*

### **The Research Experiment Using the Disc Preparative Electrophoresis Equipment for the High School Biology**

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In 2009, the Ministry of Education, Culture, Sports, Science and Technology officially announced the new curriculum guidelines for high school education, in which the importance of research experiments was continuously emphasized. It is regarded as importance that students understand the diverseness of enzyme in order to understand the diverseness of life phenomena. There were few experiments about enzyme in the present textbook of the high school Biology. Although the experiment of catalase was treated, there were few experiments of other enzyme, such as amylase and cellulase. Amylase, cellulase, etc. can be easily extracted from the culture medium of 'Koji' mold (*Aspergillus*), which has a close relation to brewing of alcohol, soy sauce, etc., and its safety is high. Isolation of enzyme requires time-consuming steps using various kinds of columns. Thus, it tried to use the equipment of Disc Preparative Electrophoresis as a tool for the easy enzyme purification. If this equipment is used, enzyme can be isolated with comparative ease. In principle this equipment can separate proteins based on SDS-polyacrylamide gel-electrophoresis (SDS-PAGE) according to the Laemmli method. The feature of this equipment is that fractions of proteins separated by electrophoresis can be directly collected through tubing by a fraction collector. The enzyme in separated fractions can be preserved in frozen storage, and it can also be utilized for various experiments.

**Keywords:** *Disc preparative electrophoresis, high school Biology, research experiment, SDS-PAGE*

### **Learners' Perception and Misconceptions on the Illustrations of Eye Vision in the Biology Textbooks**

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In Korean science textbooks, the biology unit includes the content on the visual function. This content is related both to the physics of light refraction and to the biology of controlling the eye lens. In this study we examined the errors in the illustrations in 8th, 10th, and 11th science textbooks dealing with the light path and controlling the eye lens. In addition, we examined the biology teachers' and middle and high school students' perceptions on those illustrations.

Five types of illustrations were analyzed that represent the light pathway from the object to the retina. Scientific illustrations were used in two textbooks, and other 16 textbooks contain four types of errors in illustrations. The illustrations with errors do not explain the location of image formation scientifically. From the effect of these illustrations in science textbooks, middle school students (6%), high school students (7%), and biology teachers (14%) have misconceptions on drawing the light pathway. They just memorized the fact that the reverse image is formed in the retina. The cause of myopia and hypermetropia was represented only with the length of eyeball in the textbook illustrations. In addition, the correction by lens was expressed in very complex illustrations. Almost all the illustrations represented that the image is formed in the visual focus of lens. Thus the middle school students (59%), high school students (73%), and biology teachers (31%) have misconceptions thinking the focal point and the image point are the same. In six high school biology textbooks, the control of thickness of the eye lens according to the distance of object was represented in illustrations. This process was explained with the term of contraction/relaxation of

ciliary muscles and suspensory ligaments in the cross-sectional view of eye. From these illustrations high school students (70%) and biology teachers (60%) could not understand this process scientifically.

This study shows the necessity of improving illustrations on eye vision as the fusion of physics and biology. Three-dimensional illustrations should be developed to help learners' understanding with proper explanation of terms.

**Keywords:** *Ciliary muscles, eye lens, eye vision, illustration, light refraction, misconception, perception*

### **Situation with Life and Environmental Science Education available for a Secondary School Pupil in Japan and Ukraine**

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The research concerns life and environmental science education available for school pupils (grades 7-12). It has been conducted to investigate if in Japan or Ukraine the approach is closer to present tendencies of chosen developed countries and what themes might be proposed for introduction into curriculum or sources of lifelong learning. Therefore, the evaluation is made from two perspectives: school curriculum and information available as a part of social education (television). Japan and Ukraine were chosen for the comparison as recently Japanese science education has been criticized as superficial, but social is recognized as developed, while in Ukraine the situation is opposite. Necessary for studying life and environmental science curriculums were studied, divided into themes and analyzed. The same was done for instructional time and statistic figures of prescribed, studied topics, and characteristics of the teaching process. Totally in grades 7-12 Japanese students are prescribed to learn 35-49 topics (Ukrainian students - 70) from 77, while instructional time is 2 - 3.5 times bigger in Ukraine.

Concerning sources of social education, it was investigated, in which country more life science and environmental information is available and on what topics.

The research did not intend to create a "perfect curriculum", but identified a belief, that a certain range of topics in forming an essential core of science education. If it is insufficient, the educational system will affect the economy, science (especially the ability of a country's specialists to compete with foreigners) and social issues, including environmental protection for which knowledge in biology is necessary.

**Keywords:** *Biology education, curriculum, environmental education, lifelong learning*

### **A Study of Pupil's Learning on Biodiversity in Insects**

**Lung-fei Lin, Ching-san Lai**  
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To help students to understand biodiversity and promote students' perception of life and environmental education is the main idea of this research. There are many species of insect, it is the best representative of interpreting biodiversity, the purpose of this study, through the outdoor learning, teachers lead students to explore insectariums and carry out the concept of biodiversity conservation. The subjects were 230 fourth graders students in Taipei County. This research was implemented through outdoor learning to collect data, including student study sheets for biodiversity, questionnaires of participant teachers and qualitative data to analysis and interpretation. The research instrument "Biodiversity attitude scale", with 15 questions, Cronbach's  $\alpha$  value of .80, examines student attitudes toward biodiversity. The results show that the implementation of biodiversity outdoor learning in the zoo can (i) enhance elementary school fourth graders to promote positive attitude toward biodiversity ( $t=-4.431, p<.05$ ), (ii) enhance students' concept on biodiversity in learning insects, and (iii)

enhance teachers' perception of biodiversity conservation and environmental education.

**Keywords:** *Biodiversity, environmental education, outdoor learning*

### **STEPSAM 2 and Biology Education in Cambodia**

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<sup>2</sup>*Nara University of Education, Japan*

In order to improve science education in Cambodia, the Ministry of Education Youth and Sport of Cambodia cooperates with JICA of Japan to implement one project called STEPSAM2 to enhance the capacity of primary and lower secondary school teachers in Cambodia. This project runs for 4 years, started in September 2008. Through the project, PRESET teachers are enhanced by inviting all science trainers in 18 Provincial Teacher Training Centers (PTTCs) and 6 Regional Teacher Training Centers (RTTCs) throughout the country to receive training program on teaching and learning science and to enhance INSET teachers, some primary school and lower secondary school teachers in selected schools were invited to receive the training course from TTC trainers. In the project, the quality of science education is improved by applying lesson study and acquiring pedagogical content knowledge. All science trainers and directors in every PTTC and RTTC were invited to participate in the workshop and training program on lesson study and inquiry-based lessons.

Biology education has improved through STEPSAM2. Students in all attached schools and cooperated schools throughout the country had an opportunity to study biology through inquiry-based approaches during teacher-trainee practicum. Even though their capacity to prepare and conduct inquiry-based science lessons is very limited, both trainers and trainees tried their best to implement them in their classes. The capacity of biology teachers in inquiry-based approaches will be im-

proved in the lesson study process, and all primary and lower secondary schools in Cambodia are expected to implement lesson study in the future.

**Keywords:** *Biology education improvement, INSET teacher, PRESET teacher, STEPSAM2*

### **Developing Environmental Education Program to Learn Basic Classification in River**

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Biology is one of the subject areas in Japan high school. In this subject area, students can choose to study and learn among basic classification and evolution or basic ecology of living things. The purpose of this study is to develop an environmental education program that can be applied in learning school environment such as the river. It assumes that students can acquire basic knowledge and the skill concerning the classification through this program. The results of the program showed that students learned the contents in a more enjoyable and significant ways. Moreover students can take beautiful photographs and develop essential observation skills.

**Keywords:** *Classification, environmental education, observation, teaching practice*

### **The Effectiveness of Concept Mapping Strategies for 6th Graders' Science Learning on Animal Reproduction**

**Lai Ching-san<sup>1)</sup>, Ni Chi-yao<sup>2)</sup>**

<sup>1</sup>*National Taipei University of Education,*

<sup>2</sup>*Chung-Hu Elementary school, Taiwan*

The major purpose of this study is to explore the effectiveness of concept mapping strategies for 6th graders' science learning on the unit of animal reproduction. A quasi-experimental design was used with 2 classes. One class was assigned as the experimental group, and the other was the con-

trol group. Pupils in experimental group were given science teaching integrated with concept mapping strategies on the unit of animal reproduction, while the control group received original curriculum during the same time. Two research instruments were used in this study include two-tier science achievements test and attitudes toward science scale. In addition, qualitative data such as concept maps and study sheets were collected to determine the learning effectiveness of the students from the experimental group.

The results of this study were summarized as following: The experimental group received higher scores than the control group in the two-tier science achievements test about animal reproduction. The experimental group obtained higher scores than the control group in the attitudes toward science scale. These results indicate that science teaching integrated with concept mapping strategies has significantly influenced elementary school 6th graders learning of science.

**Keywords:** *Animal reproduction, attitudes toward science, concept mapping, science achievements*

### **Assessing the Influences of Web-based Module on Circulatory System towards Students' Attitude, Learning Style, Perception and Achievement**

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Ong Kian Kok**

*Central Luzon State University, Philippines*

The study assessed the influences of web-based module on the circulatory system towards the students' attitude, learning style, perception and achievement. Twenty fourth year students belonging to the Bachelor of Science in Biology and Bachelor of Secondary Education from the intact classes in animal physiology were the respondents of the study. Personalized web-based learning system through a web-based module on the circulatory system focusing on the topics of blood, heart, blood vessels and their physiology was developed

and launched for a month for the students to use. Results of the study showed that there is a significant increase between the pretest and the posttest ( $p < 0.05$ ). No significant change on the before and after exposure to the web-based module was seen on the three learning style dimensions, particularly on active/reflective, sensitive/intuitive and sequential/global ( $p < 0.05$ ), however, a significant change was noted on the students visual/verbal learning style dimension. Students had positive attitude towards using web-based module for learning. Students perceived that the web-based module is an accessible learning tool that can bring about results in terms of their achievement based on their academic performance on the subject. The study also showed no significant evidence to indicate that the demographic characteristics, perception and learning style has significant relationship with the students achievements in their academic performance ( $p > 0.05$ ), however computer attitude was found to be correlated with the students achievements.

### **A Comparative Study of the Antibacterial Property of Slime Extracted from the Body of Purged and Unpurged *Ophicephalus striatus* (Mudfish) against *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus* and *Enterococcus faecalis***

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The manufacture of various medicines to combat most of the diseases is a call to mankind. Its production is important in prolonging the life span of an individual, along with cleanliness drive to minimize the occurrence of many diseases. The mudfish is an aquatic organism that does not mind

cleanliness and yet are able to survive in its polluted environment. How does this organism do it? This research attempts to examine the possible antibacterial property of the slime extracted from the mudfish.

Twelve *Ophicephalus striatus* (mudfish) samples were used in this study. Six of the fishes were subjected to a purging process (in this process the fishes were exposed to a clean water for six days but the water is being changed daily) and the other six were not purged and its slime directly extracted and tested for possible antibacterial property. Both the slime from unpurged and purged mudfishes were tested to the four bacteria, namely: *Bacillus subtilis*, *Escherichia coli*, *Staphylococcus aureus* and *Enterococcus faecalis* using the filter paper disc diffusion method. The collected slime were placed in a sterilized Petri plates containing sterilized filter paper discs. The wet discs were then placed into the seeded Nutrient Agar (NA). Three wet discs were placed in every Petri plate. The seeded NA plates together with the slime were then incubated for 24 hours. After 24-hours, the zone of inhibition was measured.

In the results, only the slime from unpurged mudfish showed zones of inhibition and only in plates with *B. subtilis*, *E.coli*, and *S. aureus*. No zones of inhibition were observed in the slime of purged mudfish. From the four bacteria used, it was *B. subtilis* that was considered to be more susceptible to the slime of unpurged mudfish due to the wider inhibition created around the filter paper. From the two sampled slime, unpurged and purged, it was the unpurged mudfish's slime that showed zones of inhibition. The researchers however, could not conclude that the inhibitions were due to the antibacterial property of the slime because of the presence of microbial growth on the control set-up. The control set-up is a culture of the slime in the sterile filter paper disks and was not seeded with the four test microorganisms.

**Keywords:** *Mudfish, purge-to free from impurities*

### **A Study on the Role of Biology Education for Young Children with Special Reference to Sustainable Development —through Playing with Crayfish**

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This study focuses on the development and cultivation of a scientific mind within young children through interaction with their natural surroundings. We followed three four-year-olds attending Tokyo Kasei University-Affiliated Kindergarten, closely examining how they would interact with live crayfish introduced into the kindergarten environment. To analyze the changes in their behavior, we used temporal isolation recording, comprehension tests, as well as a close analysis of the children's drawings.

We were able to observe several behavioral patterns (e.g. interest, concern, curiosity) that indicate the existence of the sprouting of a scientific mind in the children. Such patterns were especially pronounced in the Subject Y, but could also be observed in Subjects H and R in a lesser intensity. These observations suggested that a long-term continuous nature activities in early education, i.e., interaction of children with living things in nature could likely facilitate the development and the fostering of the sprouting of a scientific mind in young children, thus also contributing to their sustainable development in learning.

**Keywords:** *Playing with crayfish, pro-experience, sprouting scientific mind, sustainable development, young children*

### **Cholinergic Muscarinic Receptors Profile of Mouse Hippocampus Exposed to Nicotine during Breastfeeding Stage**

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*University of the Philippines, Philippines*

The cholinergic system that plays an essential role in attention, learning and memory is affected by

neonatal exposure to nicotine. This study evaluated the expression of muscarinic receptors on mouse hippocampus. Dams were fed with 35% nicotine in drinking water and 65% rabbit pellets. Litters that breastfed on nicotine-fed dams on postnatal days 4 - 21 were examined and compared with those of the control group. Body weight, brain weight and profile of the muscarinic receptors were examined by the use of immunohistochemical stains. Brains of nicotine-fed mice were smaller in size. Muscarinic receptors M1 and M2 and M4 were fewer than those of control mice. Neonatal exposure may have caused neuronal apoptosis that led to low brain weight and decrease in muscarinic receptors.

**Keywords:** *Cholinergic receptor, hippocampus, muscarinic receptor, nicotine*

**Protective Effect of Banaba  
(*Lagerstroemia speciosa* (L.) Pers.) on  
MSG-mice, an Animal Model for Diabetes,  
Obesity and Fatty Liver**

**Thucydides L. Salunga, Ronnellee G. Paclibar,  
Jayson John L. Magbojos**

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The metabolic syndrome is characterized by a cluster of disorders that increase the risk of cardiovascular disease. The condition is now highly prevalent in both developed and developing countries and its incidence is increasing in virtually all age groups. Thus, ultimately making metabolic syndrome an urgent target for novel approaches to reduce the burden of the metabolic syndrome upcoming consequences on global health issues. We have recently contributed to the development of a new non-genetic model of diabetes, obesity, and fatty liver. This model is induced with the peritoneal injection in newborn mice of monosodium glutamate (MSG), a common flavor enhancer and naturally occurring amino acid utilized in increasing amounts in diets. This study aimed to determine the effects of banaba leaf extract on the

body weight, body mass index, adipose tissue weight, adipose cell size and liver of MSG-mice. Results showed that MSG-treated mice had the highest weight gain, BMI, adipocyte size and liver showed fatty change and neutrophil aggregations. Moreover, adipose tissue weight and cell size were lesser in banaba-treated mice compared with MSG-mice. Also, liver histology was improved with banaba treatment.

**Keywords:** *Diabetes, herbal medicine, NAFLD, natural products, obesity*

**The Characteristic Pre-Service Teacher  
Training Curriculum Enforced at Faculty  
of Education, Hirosaki University;  
the Case of Junior High School Biology  
Education**

**Takayuki Sato**

*Hirosaki University, Japan*

There are several practical subjects on pre-service teacher training curriculum that are available at the Faculty of Education, Hirosaki University. Undergraduate 3rd grade students have to complete two practical subjects. These are, "Intensive Practice" in summer and "Tuesday Practice" throughout the year. "Tuesday Practice" is implemented regularly every week. Therefore, students can observe class activities continuously, and study the processes of learning. Furthermore, students can create and teach classes to improve their skills to that of becoming teachers. In junior high school, students attend science class activities on attachment at the junior high school of the university on Tuesday afternoons. They are able to attend the classes about fifteen times in a year. Students taught several biology classes. The themes of the lessons were: "Structure and Contraction of Muscles," "Dissection of Fishes," "Dissection of a Cuttlefish," "Connection from Eyes to Brain," "Instinctive Behaviors of Animals," "Learning Curve of Human," "Ferns and Mosses," "Pigments of Plants," "Classification of Plants

Closed to Us,” “Heredity and DNA,” and “Utilization of Living Things for Human Life.” Students can obtain y merits in this “Tuesday Practice.” They are given many opportunities to observe learning processes continuously. Moreover, they can teach classes which with advanced learning contents. However, the practice has some demerits. One of them is about the time scheduling. Students have to reflect and supplement their lack of skills for only one year as undergraduate 4th grade.

**Keywords:** *Advanced learning contents, biology activity, constantly practical subject, reflection and supplement, Tuesday Practice*

### **A Study of the Learning Outcome on the Teaching of Biodiversity in the Zoo for Fifth Grade Students**

**Tsun-hui Shih, Ching-san Lai**

*National Taipei University of Education, Taiwan*

Biodiversity is the foundation of mankind's survival and welfare. To positively maintain biodiversity will ensure the needs of survival for human beings. The Taipei Municipal Zoo is an abundant area of living-creature resources, and is an excellent place that is suitable for experiencing learning of biodiversity and recreation.

The purpose of this study is to evaluate the influences of this instruction on the fifth grade students' concept of biodiversity and their attitudes toward biodiversity conservation, through the teaching activities of biodiversity in the zoo. A quasi-experimental design was used in this study. The subjects were two classes of the fifth graders in an elementary school in Taipei County. One class was the experimental group who received the teaching of biodiversity in the zoo, while the other was the control group who received the conventional instruction. The research tools used in this study include “the Learning Achievement Survey of Biodiversity” and “the Scale of the Attitude toward Biodiversity Conservation” and the

pre-test/post-test questionnaire was used in this study to assess the outcome effects. The main findings of this study were as follows: (i) with the involvement of experimental courses, the students' biodiversity concepts are greatly improved, and (ii) with the involvement of experimental courses, the students' attitudes toward biodiversity conservation are greatly improved.

**Keywords:** *Attitudes toward conservation, biodiversity, teaching in the zoo*

### **Health Impacts of Eating Food Contaminated with Dioxins**

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Dioxin is ubiquitous in the environment especially in the industrial areas, in air, water and soil, as well as in food. Human exposure to dioxin can occur through working in industries where dioxin is a by-product, industrial accidents, through food, and drinking water. In general, food of animal origin contributes to about 80% of the overall human exposure. Meat, eggs, milk, farmed fish and other food products may be contaminated by dioxins from animal feed. Soil is a natural sink of dioxins. Apart from atmospheric deposition, soil may be polluted by sewage sludge or composts, spill and erosion from nearby contaminated areas. Soil is absorbed via dust deposits on vegetables, by grazing cattle, goats, sheep and chicken, including burrowing/grazing pig and wild animals. Dioxins are poorly water soluble substances, but are absorbed onto mineral or organic particles in suspension. When dioxins are transported by air to the surface of oceans and seas they end up concentrating along the aquatic food chains. Dioxins have a broad series of toxic and biochemical effects and some are classified as known human carcinogen. In laboratory animals they have been linked to endometriosis (severe effects on the uterus), neuro-

behavioral effects (learning disabilities), developmental reproductive effects (low sperm count, genital malformations) and immunotoxic effects. These effects occur at much lower levels of exposure than carcinogenic effects. As human are on top of the food chains and have long life span, the longer we live, the more dioxins accumulated in blood and tissues.

**Keywords:** *Human carcinogen, toxic carcinogen*

### **Gleaning Methods and Extraction Rate of Holothurians in Camotes Islands, Central Philippines**

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Lourdes M. Garciano, Berenice T. Andriano**  
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Camotes Islands is noted of its Camotes Sea as one of the fishing grounds in the Philippines. Extraction of the marine resources including holothurians in this fishing ground has been felt by the fishermen; hence, this study was conducted in order to find out its gleaning methods used, species gleaned, extraction rate and perception on the distribution of holothurians in the four municipalities of Camotes Islands which are San Francisco, Poro, Tudela and Pilar. Interview guide and actual field visits in the areas were used to gather the data.

Results show that gleaning methods of gathering holothurians in Camotes Islands were handpicking, using bolo, water goggles, pointed wood, iron bars and by spears both in day and night operations. Frequently gleaned sea cucumber species are *Stichopus hermanni*, *Bohadschia paradoxa*, *B. marmorata*, *Stichopus horrens*, *Holothuria nobilis*, *S. variegatus* and *H. pulla* which are also the species that were caught throughout the year.

The size of the Holothurians gathered measures from 5 - 10 cm and the perceived distribution distance of gleaned holothuria in the site is 1 - 5 m. The amount of catch is  $\hat{A}$ ½ kilo per 1 - 2 hours

gleaning time followed by no catch and the third is 0.51 to 1.0 kg and the gleaning frequency of holothurians in the entire Camotes Islands is 2 - 4 times a week.

**Keywords:** *Camotes Islands, extraction rate, glean, Holothurians*

### **An Exploration of Biological Concept Formation in the Classroom**

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Concept formation takes a long time and is very complex in daily life, so most psychologists have used artificial materials to test the process of concept formation. Bouthilet (1948) used the Hypothesis Testing Model to research concept formation. In the Hypothesis Testing Model, subjects realize the character of a concept through discovery. However, in classroom conditions, students understand the character of a concept through learning. Brooks *et al.* (1978) tested the effects on concept formation of the learning conditions produced by different instruction models. However, they also used artificial material during tests. What about concept formation in relation to scientific concepts in the classroom? And what about differences in concept formation for different scientific concepts? This experiment explores biological concept formation in the classroom by means of the hypothesis testing model. Sixty students were randomly selected from Grade 1 classes of one high school. In accordance with the corresponding concept character, the author compiles the test, which includes 10 sections, each of which contains 5 questions. The questions in the test were all multiple-choice questions. Each question has five options, with one correct answer.

The results suggest: firstly, that the character of biological concept formation is to begin at a higher level, grows slowly and then oscillates on a plateau, without the phenomena of mutative process; sec-

only, that the inquiry model of instruction is more efficient in concept learning; and thirdly, that there may be a threshold for concept learning.

**Keywords:** *Begin at a higher level, biological concept, grow slowly, oscillate on a plateau*

### **A Study of the Value of Education in the History of Bioscience to the Training of Students' Innovative Thinking**

**Ying-chun Zhang, Yan-ting Tang**  
*Shaanxi Normal University, China*

In view of the fact that the traditional classroom teaching does not give due attention to students' innovative thinking, ignore the scientific idea and the construction of scientific concepts, the study

discusses the intrinsic value of education in the history of bioscience in high school biology curriculum. The study posits that the history of bioscience reflects the essential purpose of science education as well as conforming to the law of students' thinking development and has a great value in the training of students' innovative thinking, such as inspiring innovative thinking, providing the innovation development paradigm, showing the process of innovative thinking and reflecting the nature of the innovative thinking.

**Keywords:** *Education in the history of bioscience, innovative thinking, science education, scientific thinking*

#### **From the Editor**

I have to apologize for delaying the publication of this issue. The sixth volume of the *Asian Journal of Biology Education* (AJBE) contains two research papers and the abstracts of the presented papers at the 23rd Biennial Conference of the AABE, which was held at the National Institute of Education, Singapore, from the 18th to the 20th of October, 2010.

Still, I have some articles submitted from the AABE members and other contributors. These articles may be included in the next issue which will be published soon. The next issue will include the abstracts of papers presented at the 24th Biennial Conference of the AABE which was held at University of the Philippines, Diliman, Quezon City, Philippines, from 5 to 9 December, 2012.

As the members of the Editorial Board will be changed from the next issue, I deeply appreciate their contribution to the publication of three volumes of the *AJBE*.

I am very thankful to the following persons for their effort to review the articles which are included in this volume: Dr. Mitsuo Matsuka (Professor Emeritus of Tamagawa University), Professor Shigeki Mayama (Tokyo Gakugei University), and Dr. Robert Wallis (University of Ballarat).

**Dr. Nobuyasu Katayama**