DEVELOPMENT OF E-LEARNING INSTRUCTIONAL MATERIALS FOR THE ICNS152 SOUTHEAST ASIA ECOLOGY COURSE

Ramesh BOONRATANA¹ & Yubol BOONJARAN²

MAHIDOL UNIVERSITY INTERNATIONAL COLLEGE

INTRODUCTION

Electronic learning or e-Learning typically comprises all forms of electronically and technologically supported information and communication systems meant to serve as one means of implementing the learning and teaching processes, which can be employed for the out-of-classroom situation at both the learners’ and the teachers’ convenience, and for supporting or enhancing the learners’ in-classroom educational knowledge acquirement and experiences. In addition, the development of e-Learning has allowed knowledge to be accessed by a wider group of audience, beyond those typically associated with educational institutions.

Hence, in line with Mahidol University’s vision and policy towards the provision of knowledge-based services, instructional materials for the ICNS152 Southeast Asia Ecology course, a General Education science course offered to the undergraduate students of Mahidol University International College (MUIC), were developed with the following objectives and justifications:

i. To allow students registered for the ICNS152 Southeast Asia Ecology course to access, review, and revise the course contents at their convenience from any location, and to reduce the time required for effective learning, therefore improving flexibility of the course delivery.

ii. To motivate student learning, as e-Learning can be an effective means to keep abreast of articles on recent findings and observations, new technology, and to keep the learners inspired and encourage them to generate new ideas.

iii. To allow learners to have a better understanding and appreciation of the natural and human-modified ecosystems, the threats they are facing, benefits of the ecosystem services to humans, and the relationship between ecosystem protection and sustainable development.

iv. To allow the public (students and non-students) access to interactive user-friendly educational materials that would otherwise be beyond their time availability and more importantly, beyond their economic means (e.g., school fees, tutor costs, travelling costs, costs of printed materials).

The overall purpose of the ICNS152 Southeast Asia Ecology course is to offer an overview of the ecological systems of Southeast Asia, and to discuss the current impacts and potential threats to them. The course further looks at the protected area system and its role in protecting intact ecosystems, in the conservation of biological diversity, in providing ecological services, and as a key component of ecotourism. In addition, the course looks at the relationship between ecosystem protection and sustainable development, and the international

¹ Science Division, Mahidol University International College, 999 Buddhamonthon 4 Road, Nakhon Pathom 73170, Thailand. Tel: +6624415090 Ext. 3543 E-mail: ramesh.boo@mahidol.ac.th
² Audio Visual Section, Mahidol University International College, 999 Buddhamonthon 4 Road, Nakhon Pathom 73170, Thailand. Tel: +6624415090 Ext. 3414 E-mail:yubol.boo@mahidol.ac.th
conventions that relate to ecosystem protection. Finally, the course provides some eco-friendly guidelines for developers and planners.

Upon completion of the course, students are expected to be able to:

i. Recognize the main natural and human modified ecosystems found in SE Asia.

ii. Describe the main distinguishing features of the natural and human modified ecosystems in SE Asia.

iii. Understand and identify the threats and impacts to the natural and human modified ecosystems in SE Asia.

iv. Understand ASEAN’s environmental challenges, and the meaning of climate change and the significance of its impacts.

v. Understand the concepts and importance of protected areas, biodiversity conservation, and ecosystem services.

vi. Appreciate the importance of sustainable development.

vii. Understand the concept of ecotourism and its importance to protected area management and biodiversity conservation.

viii. Gain better knowledge of international mechanisms for ecosystem protection and biodiversity conservation.

ix. Learn and apply some eco-friendly guidelines for advising developers and planners.

Furthermore, students are expected to partake in a field trip to observe some of the ecosystem types present in Thailand. Students will learn about the management of ecosystems and issues threatening the integrity of those ecosystems. Students are also required to submit trip reports highlighting their experiences, provide an evaluation and assessment of the management observed, and make recommendations or suggestions for its improvement.

The nature and scope of the ICNS152 Southeast Asia Ecology course and the diversity of topics and sub-topics offered therein (see table 1) therefore allows for numerous opportunities in the development of e-Learning instructional materials for the course. To develop all possible e-Learning instructional materials for the course would require, however, much time, effort, and funds. Thus, the development of e-Learning instructional materials for the course will be feasible only when carried out in several phases. For the first phase, the aspects of the topics and sub-topics selected are described in the following section.

**MATERIALS AND METHODS**

The core team comprised the senior author (RB) in his capacity as the course instructor, team leader, and the content designer of the e-Learning instructional materials, and the co-author (YB) whose primary tasks were to acquire, coordinate, and communicate between the senior author and the experts employed for the development of the e-Learning instructional materials. The overall workplan and tasks accomplished within the first phase of 12 months are summarized in table 2, and the content design of instruction materials deemed feasible within the timeframe and budget is presented in table 3.
<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
</tr>
</thead>
</table>
| 1    | • Introduction to Southeast Asia  
      • Introduction to Ecology |
| 2    | • Ecological Overview of Southeast Asia |
| 3    | • Natural Ecosystems: Mangrove Forest, Beach Vegetation, Brackish-water Forest, Rocky Shores, Coral Reefs |
| 4    | • Natural Ecosystems: Rivers and Lakes, Peat swamp Forest, Freshwater-swamp Forest |
| 5    | • Natural Ecosystems: Lowland Forest, Mountains, Caves |
| 6    | • Mid-term Examination  
      • Man-made Ecosystems: Impacts and Threats |
| 7    | • Man-made Ecosystems: Agricultural Ecosystems, Urban Ecology |
| 8    | • Protected Areas: Definition, Concept and Categories |
| 9    | • Biodiversity Conservation  
      • Ecosystem Services |
| 10   | • Sustainable Development  
      • Ecotourism: Definition and Concept |
| 11   | • International Conventions and Ecosystem Protection  
      • Ecologically-friendly Guidelines for Developers and Planners |

Table 2: Planning framework

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Activity plan</th>
<th>Duration (months)</th>
<th>Project Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Planning &amp; Preparation</td>
<td>a. Identify expertise</td>
<td>X</td>
<td>Expertise identified &amp; draft workplan established</td>
</tr>
<tr>
<td></td>
<td>b. Discuss instructor’s needs</td>
<td>X</td>
<td>Instructor’s needs identified</td>
</tr>
<tr>
<td></td>
<td>c. Determine media type</td>
<td>X</td>
<td>Media type and materials identified</td>
</tr>
<tr>
<td></td>
<td>complementary to instructor’s needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>b. Testing &amp; correcting e-Learning materials</td>
<td>X</td>
<td>e-Learning materials tested, corrected, and available online</td>
</tr>
<tr>
<td>Topics</td>
<td>Instructional Materials</td>
<td>Purposes</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------</td>
<td>----------</td>
<td></td>
</tr>
<tr>
<td>1. Introduction to Southeast Asia, ASEAN, and ASEAN’s forest cover</td>
<td>1.1 Animation of the SE Asia</td>
<td>• To allow geographically challenged learners to better able locate countries in SE Asia and in the ASEAN.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.2 Animation of ASEAN</td>
<td>• To allow learners to better able distinguish SE Asia as a biogeographic region as opposed to the member countries that make up ASEAN.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.3 Animation of SE Asian and ASEAN’s forest cover</td>
<td>• To allow learners to obtain a better overview of the forest types and their distribution, and the extent of forest cover in SE Asia and the ASEAN member countries. • To allow learners to obtain a better visualization of the loss of forest cover and to emphasize the need for protect the remaining forests.</td>
<td></td>
</tr>
<tr>
<td>2. Mangrove forest ecosystem</td>
<td>2.1 Animation of the mangrove forests.</td>
<td>• To assist learners in visualizing mangrove forest ecosystems and the unique environmental conditions with which they are associated. • To allow learners to understand the physiological adaptations that mangrove plant species have adopted to survive the harsh environmental conditions of the coastal areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 Animation of vivipary and seed dispersal by water.</td>
<td>• To illustrate a unique form of germination observed in some mangrove plant species. • To illustrate seed dispersal by water, and a species’ unique strategy for survival.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.3 Animation of an ecological service provided by the mangrove forest ecosystem.</td>
<td>• To illustrate some of the physical functions of the mangrove forest ecosystem in fulfilling the role of buffering the impacts of waves, storms, and tsunami.</td>
<td></td>
</tr>
<tr>
<td>3. Lowland rainforest ecosystem</td>
<td>3.1 Short video clips of some of the components of the lowland forest ecosystem and protected area management.</td>
<td>• Video clips accompanied by the course instructor’s commentary, to illustrate some of the salient features the lowland forest ecosystem, threats, and impacts they are facing and some to the issues related to protected area management.</td>
<td></td>
</tr>
<tr>
<td>Topics</td>
<td>Instructional Materials</td>
<td>Purposes</td>
<td></td>
</tr>
<tr>
<td>--------</td>
<td>------------------------</td>
<td>---------</td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Animation of the fig wasp cycle and fig pollination by fig-wasps and figs.</td>
<td>• To illustrate the fig-wasp cycle, fig pollination, and the unique mutualism exhibited between fig wasps and fig species.</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Animation of the modes of coexistence among wildlife species occupying the tropical lowland forest ecosystem, and details of the wildlife species exhibited in the animation.</td>
<td>• To illustrate the specializations and strategies that wildlife species adopt that enable them to coexist at high densities and diversity in an intact tropical lowland forest ecosystem. • To provide detail descriptions of the wildlife species illustrated in the animation, and these include the species’ taxonomic notes, global threatened status, geographic range and distribution map, population status, habitat and ecology, and threats to their survival.</td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Multimedia slideshows of students’ field trips.</td>
<td>• To allow learners a lighthearted view and a record of their field trips to a lowland forest ecosystem.</td>
<td></td>
</tr>
</tbody>
</table>

Various expertise were acquired to achieve the instructional materials as outlined in table 3, and they comprised Ms. Nichaporn Surinwong (for items 1.1, 1.2, and 1.3), Mr. Vorsate Arcade (for items 2.1, 2.2, 2.3, 3.2 and 3.3), the MUIC Audio-Visual team comprising the co-author (YB), Mr. Thammachart Kanjanapinyo, Mr. Chayanon Poonthong, Mr. Natthapong Buasai, and Mr. Chalat Buthkun (for item 3.1), and Ms. Nuchjaree Chantorn (for item 3.4).

The design, development, corrections, and production of the first phase of the e-Learning instructional materials for the ICNS152 Southeast Asia Ecology course took almost a full year, running from June 2010 to May 2011.

**THE PRODUCTS**

With reference to the instructional materials listed out in table 3, the finished products comprised the following:

1. **Introduction to Southeast Asia, ASEAN, and ASEAN’s forest cover**
   
   **1.1 SE Asia**

   The SE Asia is a sub-region in Asia that is geographically south of China, east of India and north of Australia. This sub-region can be further categorized into the Asian mainland, and the island arcs and archipelagoes to the east and southeast. The former comprise Cambodia, Lao, Myanmar, Thailand and Viet Nam, and the latter comprise Brunei, Timor-Leste, Indonesia, Malaysia, the Philippines and Singapore.

   The animation starts with an illustration of the planet Earth and the regions therein, followed by an illustration of the SE Asia as a biogeographic region (figures 1.1 & 1.2).
1.2 ASEAN

The Association of Southeast Asian Nations or ASEAN was established on 8 August 1967 in Bangkok by the five original Member Countries, namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand. Brunei Darussalam joined on 8 January 1984, Viet Nam on 28 July 1995, Lao PDR and Myanmar on 23 July 1997, and Cambodia on 30 April 1999.

The animation similarly starts with an illustration of the planet Earth and the regions therein, followed by an illustration of the ASEAN member countries (figures 2.1 & 2.2).

1.3 Forest Cover

As in items 1.1 and 1.2, the animation begins with an illustration of the planet Earth and the regions therein (figures 3.1), followed by an illustration of the countries in and adjoining SE Asia (figure 3.2). Users are able pan around the region or zoom in to a particular area for more detailed information (figures 3.3 & 3.4). The forest cover also shows the forest types found in the region.
2. Mangrove forest ecosystem

2.1 Mangrove Forest Ecosystem

The mangrove ecosystem is a very distinct ecosystem that occurs in saline coastal habitats (both marine and brackish environments) primarily in the tropics and subtropics (where annual rainfall is relatively high), frequently near the mouths of large rivers and in sheltered bays (Whitten et al., 1987; Osborne, 2000; Giesen et al., 2007). There is also much sedimentation at the mouths of these large rivers. The mangrove ecosystem is generally restricted to the tidal zone i.e. the area on the coast from the lowest water level up to the highest high water level (Whitten et al., 1987; Osborne, 2000).

The mangrove vegetation include trees, shrubs, ferns and palms that typically grow in extreme environmental conditions, that include soils with low oxygen content, salinity and frequent tidal inundation. However, the mangrove vegetation have developed a set of physiological adaptations to survive the problems of low oxygen content, muddy, shifting, saline conditions (Whitten et al., 1987; Osborne, 2000; Giesen et al., 2007).

The mangrove flora comprises several species that occupy varying microhabitats. Some species prefer more salinity, growing closer to the shore, while others prefer to be closer to fresh water, growing inland. Some species prefer areas that are sheltered from waves, and some have their roots covered with seawater during the high tide. Some species
prefer growing on dry land, but are part of the mangrove ecosystem (Whitten et al., 1987). Nevertheless, mangroves apparently develop well in areas with high rainfall and runoff, particularly along the riverbanks of estuaries (Osborne, 2000).

Given frequent or permanent inundation, mangrove trees therefore need to keep their trunks and leaves above the water line, while simultaneously firmly attached to the ground so they will not be dislocated by the waves (Whitten et al., 1987; Osborne, 2000; Giesen et al., 2007). Mangrove trees have special aerial roots, pneumatophores, and salt-filtering taproots that enable them to thrive in the muddy and saline conditions (Whitten et al., 1987; Osborne, 2000; Giesen et al., 2007). Aerial roots and pneumatophores project above the mud and water in order to absorb oxygen from the environment. The parts of a root that appear above the waterline then transfer oxygen to the plant below the waterline. The aerial roots, pneumatophores, and taproots can filter out the salt from the saline/brackish water. A number of mangrove plant species possess stilt and buttress roots to improve stability in the soft and unstable muddy substrate.

The animation illustrates some features of the mangrove forest ecosystem, such as its location along the estuaries (figures 4.1), the inundation it regularly encounters, and its specially adapted roots (figure 4.2). The animation further illustrates vivipary and seed dispersal by water (see section 2.2), and a physical function of the mangrove ecosystem (see section 2.3).

Figure 4.1: Mangrove ecosystem

Figure 4.2: Submerged mangrove roots

(AR Marker)

2.2 Vivipary and Seed Dispersal

Vivipary is a unique feature of the mangrove vegetation that characterizes many typical mangrove tree genera, such as Avicennia, Bruguiera, Ceriops and Rhizophora i.e. the seeds germinate while still attached to the mother plant (Osborne, 2000; Giesen et al., 2007). Mangrove plants that exhibit vivipary can disperse their seeds by water, and plants dependent on water dispersal will have fruits or seeds that can float. These fruits/seeds can disperse over long distances, and will usually germinate upon reaching shallow waters or when in contact with a firm substrate.

Seed dispersal refers to the transportation of seeds by an agent or agents to a place away from the parent plant where the seeds will have the opportunity to germinate, grow, and reproduce (Whitten et al., 1987). Seed dispersal can be a viewed as means of ensuring reproductive success by reducing intra-specific competition for resources, and by reducing chances of being predated upon (Whitten et al., 1987). Seeds of different plant species can develop different strategies for dispersal, such as dispersal by an explosive mechanism or by wind, water or animals (table 4) (Whitten et al., 1987; Whitmore, 1998; Richards, 1996).
The animation illustrates vivipary as exhibited by some mangrove vegetation (figure 5.1), and illustrates how the germinated seeds attach themselves onto the soft muddy substrate (figure 5.2) and develop into saplings (figure 5.3). The animation further illustrates seed dispersal by water by those species that exhibit vivipary (figure 5.4). Controls allow e-Learning users to pause and mute the animation.

2.3 Buffer against Waves and Storms

The mangrove ecosystems serve many important functions, directly and indirectly beneficial to humans. These functions can be broadly grouped into physical, biological and commercial (Whitten et al., 1987; Osborne, 2000; Giesen et al., 2007). Among the many physical functions of the mangrove forest ecosystem is that it serves as a buffer against extreme natural events. Its roots and trunks slow the water's flow preventing or reducing impacts from wind action, wave action, storm, hurricanes, and tsunamis in coastal areas, minimizing damage to property and the loss of life.

The animation shows the impacts of tsunami on coastal areas in the presence and in the absence of an intact mangrove forest ecosystem (figures 6.1 & 6.2). Controls allow e-Learning users to pause and mute the animation.
3. Lowland rainforest ecosystem

3.1 Aspects of the Tropical Lowland Forest Ecosystem

A tropical rainforest flora is characterized by an abundance of thick climbers, vines and epiphytes; a closed canopy formed by broadleaf evergreen trees, large buttressed trees, and tall smooth-barked trees; a relatively open forest floor, and comprising mainly small trees and herbs (Whitten et al., 1987; Richards, 1996; Whitmore, 1998). The high plant diversity in tropical lowland forests is due to a number of factors that include varying levels of light, humidity, temperature, higher nutrients, rapid decomposition, and rainfall. In turn, the high animal diversity is associated with the structural and taxonomic heterogeneity of the plants (Whitten et al., 1987; Richards, 1996; Whitmore, 1998).

Video recordings of an actual field trip to the lowland forest ecosystem were made. These recordings were later edited to comprise several short video clips of about three minutes in duration to illustrate a particular aspect of the lowland forest ecosystem, and some observable biodiversity conservation and ecosystem management and issues (figures 7.1 to 7.10). The video clips allow e-Learning users to directly access and view a particular aspect of the lowland forest ecosystem. In addition, each video clip also contains a running commentary in the form of the instructor describing and explaining the particular aspect and its related ecology or issues, and the responses to questions put forth by the students partaking in the field trip.

Some of the features typically observed and described during a typical field trip to a tropical lowland forest ecosystem include:

- root system
- mycorrhiza
- cauliflory
- buttresses
- climbers
- epiphytes
- myrmecophytes
- rotten trunks and dead trees
- mineral licks
- figs and fig-wasp cycle
- seed dispersal
- wildlife diversity and modes of coexistence
- wildlife ecology and behavior
- secondary wildlife signs
- disturbance and succession
- role and functions of the lowland forest ecosystem
- tourism management
- wildlife management
- waste management

Figure 7.1: Mineral lick

Figure 7.2: Alien invasive species

Figure 7.3: Strangler figs and keystone resource

Figure 7.4: Nutrient cycle and microhabitats

Figure 7.5: Primary lowland tropical forest

Figure 7.6: Buttressed tree
3.2 Figs and Fig Wasps

Figs, in addition to being keystone resource for forest animals and humans, are one of the most interesting groups of plants (Whitten et al., 1987; Whitmore, 1998), being widely distributed throughout the forests and available all the year round, with one fig plant or the other fruiting at any given time. The fig fruit, although ecologically considered a fruit, is actually a syconium, an inflorescence whose walls arch over and around so that the inflorescence is somewhat enclosed (Whitten et al., 1987; Richards, 1996).

The fig plant has unique form of pollination. Its flowers are exclusively pollinated by tiny fig-wasps, with both figs and wasps totally dependent on one another for their survival. Furthermore, one species of fig-wasp is generally specific to a species of fig plant (Whitten et al., 1987; Richards, 1996). The pollination process starts with the development of the flowers, which attract the female wasps. One or more female wasps enter the fig and each female wasp deposits her egg, and in the process ‘unintentionally’ collects pollen, which are then transferred to another fig, and the process is repeated several times (Whitten et al., 1987). The larvae develop and pupate, the male pupae search for the female pupae and fertilize them, and upon maturity, the impregnated female wasp flies out and repeats the process (Whitten et al., 1987).

The animation (figures 8.1 to 8.10) illustrates the fig wasp cycle, and the animation is subtitled to describe particular segments of the cycle. The animation has a pause control that
allows e-Learning users to view the animation at their pace. The segments of the animation comprise:

i. The front page of the animation (figure 8.1).

ii. The tropical lowland forest and some fig trees; and controls to play and pause the animation, and to mute the accompanying background music (figure 8.2).

iii. A pollen-laden female wasp enters the syconium of an unripe fig through an opening known as the ostiole (figure 8.3).

iv. The wasp lays eggs within some of the flowers in the syconium. In the process the insect pollinates the other female flowers (figure 8.4).

v. Flower ovaries that contain wasp larvae form enclosing gall-like structures. The pollinated flowers without larvae produce seeds for the fig plant (figure 8.5).

vi. As the fig matures, male wasps emerge first from the galls. They then travel the syconium in search of female wasps, fertilizing them while the females are still in their galls (figure 8.6).
vii. Male flowers have matured by the time the mated female wasps emerge from their galls (figure 8.7).

viii. Without ever leaving the syconium, the wingless male wasps dig escape tunnels for their mates and then die (figure 8.8).

ix. After collecting pollen from mature male flowers within the ripe fig, the mated female wasp escapes through the tunnel (figure 8.9).

x. The female wasp, carrying pollen, flies to another fig tree in search of a syconium in which to lay her eggs. She dies within the syconium soon afterward (figure 8.10).
3.3 Modes of Coexistence

The tropical lowland forests in addition to exhibiting a high density and diversity of plants also exhibit a high density and diversity of animals, more than any other terrestrial ecosystem. Although information on species diversity of higher animals is almost complete, however there apparently remain many species of insects and other invertebrates not known to science. In fact, there have been a few large mammal discoveries in SE Asia within the last two decades that have surprised both the scientific community and the global community (e.g. Saola, large antlered muntjac, dark Annamite muntjac).

In addition, studies in the tropics have shown how so many animals can coexist in the same forest, primarily because different species occupy different niches, although the niches may overlap to varying degrees. These modes of coexistence (table 4) include specialization in space, diet, and breeding sites (Whitten et al., 1987; Whitmore, 1998).

Table 4: Wildlife’s modes of coexistence

<table>
<thead>
<tr>
<th>Specialization</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specialization in space</td>
<td>Different species of animals are active at different times of the day, some during the day (diurnal), some at night (nocturnal), some at dawn and dusk (crepuscular), and some with sporadic and random intervals during the day or night (cathederal). In addition, some species of animals occupy all levels of the canopy while others restrict their activities only to certain layers.</td>
</tr>
<tr>
<td>Specialization in diet</td>
<td>While most species of animals can be grouped as omnivores, as carnivores, and as herbivores; there are others that specializes in feeding predominantly or exclusively on leaves only (folivores), on fruits only (frugivores), on insects only (insectivores), on fish only (piscivores). Even those that feed on fruits and/or leaves may further specialize in feeding immature leaves and unripe fruits, or those plant parts that other species find toxic. Some even specializes in feeding on dead or decaying matter (carrion-eaters or scavengers).</td>
</tr>
<tr>
<td>Specialization in breeding sites</td>
<td>Some species may breed in water (some in still water and some in running water), on trees (some on branches, in tree cavities, amongst tree roots), on and in the ground.</td>
</tr>
</tbody>
</table>
The animation on co-existence of tropical wildlife allows e-Learning users to view and understand how diverse animal species can coexist in the same intact tropical lowland forest ecosystem, by developing specializations to exploit one or more ecological niches. A number of controls accompany this animation:

i. e-Learning users can scroll the animation up or down to illustrate the vertical stratification of a typical lowland forest ecosystem, and to illustrate animal species’ specialization in space (figure 9.1a).

ii. e-Learning users can also mute the background music that accompanies the animation (figure 9.1b)

![Figure 9.1: Controls for specialization in space and for muting the sounds](image)

![Figure 9.2: Controls for specialization in time](image)

iii. By clicking on the controls for the specialization in time (figure 9.2), e-Learning users can view some of those species that are active at night (figure 9.3), by day (figure 9.4), at dawn and dusk (figure 9.5), and at sporadic and random intervals (figure 9.6).

iv. Each control for the specialization in time is accompanied by another set of controls that highlight the animal species that are active during the period of day selected.

![Figure 9.3: Nocturnal animals](image)

![Figure 9.4: Diurnal animals](image)
v. Upon clicking the animals illustrated for each specialization in time (figure 9.7), e-Learning users will be directed to the animal concerned, highlighted for better visibility (figure 9.8).

vi. In addition, an additional control appears near the highlighted animal urging users to click on it.

vii. Upon clicking highlighted ‘click’ (figure 9.8), a window pops up to reveal a photographic illustration of the animal, and its specializations in time, substrate and breeding ground, and diet (figure 9.9). The pop-up window can allow e-Learning users to obtain more details of the animal by clicking on the ‘more’ control.

viii. Clicking on the ‘more’ control allows the e-Learning users to access the animal’s details from the IUCN Red List of Threatened Species database (figure 9.10). The comprehensive information include the animal’s taxonomic notes, global threatened status, geographic range and distribution map, population status, habitat and ecology, and threats to their survival.
3.4 Field Trips Multimedia Slideshows

Selected photographs and video clips of the ICNS152 Southeast Asia Ecology students’ field trips to a lowland forest ecosystem are compiled into short multimedia slideshows. These multimedia slideshows not only serve as records of the field trips, but also serves to encourage them to appreciate, and hopefully to contribute to biodiversity conservation and ecosystems protection (figures 10.1 & 10.2).

CONCLUSION

The e-Learning instructional materials allow users to access, review, and revise the materials at their convenience from any location. Instead of being viewed as a replacement to traditional modes of teaching, the e-Learning instructional materials reinforce the course’s teaching and learning. In addition, preliminary observations and opportunistic qualitative assessment indicated that registered users have much benefitted from the e-Learning instructional materials for the ICNS152 Southeast Asia Ecology course, and the instructional materials have indeed reinforced the users’ learning and understanding of the course.
ACKNOWLEDGEMENTS

We wish to acknowledge the Mr. Vorsate Arcade, Ms. Nichaporn Surinwong, Ms. Nuchjaree Chantorn, and the MUIC’s Audio Visual staff comprising Mr. Thammachart Kanjanapinyo, Mr. Chayanon Poonthong, Mr. Natthapong Buasai, and Mr. Chalat Buthkun for providing their expertise in developing the e-Learning instructional materials, and Mrs. Soumalie Visetratana (MUIC’s Associate Dean for Administration) for backstopping the project. We further wish to acknowledge the Mahidol University International College for funding this project.

LITERATURE CITED