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Remote Sensing: An Environmentally Friendly Tool to Enhance Environmental Education at the Department of Remote Sensing, Universiti Teknologi Malaysia.

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ABSTRACT: Environmental education (EE) is a learning process that develops people's knowledge, awareness and understanding about the environment, investigates about environmental problems and develops critical–thinking, problem solving and effective decision making skills related to particular environmental problems. Integrating remote sensing (RS) technology into environment is a new way to promote EE where RS is being used as a tool to explore environmental problems and find quick and best solutions to the problems. B.Sc. (RS) at Department of RS, Universiti Teknologi Malaysia (DRSUTM) was introduced in 1997 and it has been offering remote sensing, environmental and other subjects to a group of undergraduate and postgraduate students.

1. INTRODUCTION

Environmental education (EE) is a learning process that increases people's knowledge, awareness and understanding about the environment and how humans are part of and influence the environment. EE encourages the learners to inquire and investigate about environmental problems and develop critical–thinking, problem solving and effective decision making skills related to particular environmental problems (EPA, 1999).

In the absence of man, the environment attains sustainability through the interrelationship exist among the systems. However, man has become an important factor in the environment where he modifies it through his actions. Among the important consequences of human activities due to the lack of environmental knowledge that have brought to the environmental degradations are; ozone depletion, increases of runoff and sediment yield, coast erosion acceleration, atmospheric pollution, extinction of flora and fauna etc.

As a result of this, EE strategy has emerged over the past few years in order to enhance thinking, problem solving and effective decision making skills and teaches individuals to weigh various sides of an environmental issues before take any actions that can affect the environment. In this way, environmentally friendly citizens who understands the concepts and complex processes of the environment and therefore cares and appreciates the environment are produced.

EE can be channeled to every human via various ways. Governmental and non governmental organizations have been playing a significant role in environmental awareness. In Malaysia environmental awareness is stimulated by the Department of Environment under the Ministry of Science and Environment and other non- governmental organisations. Among others, learning institutions especially universities are one of the awareness centres which play a pivotal importance in embedding environmental awareness through its' curriculum.

EE has been taught at various departments at universities. However, integrating EE with remote sensing technology is rather a new and efficient way to promote EE. RS is being used as a tool to explore environmental problems and find quick and best solutions to the problems. RS is one of fastest technology to detect and seek solutions for environmental problems. It is also environmentally friendly tool as its measurement system unlike insitu equipment does not modify or destroy the environmental parameters being measured. RS has been widely used by many countries to detect, monitor and provide online information about the environment or environmental problems covering areas as diverse as atmosphere, ocean, land or ice field.

With the increasing importance given to remote sensing and related technologies in order to fulfill the human resource development needs in Malaysia, a four year undergraduate programme was started in May 1997 at UTM leading to the B.Sc. (Remote Sensing) Degree (refer Kasturi et al, 2000 for more details about the 4 year

programme). Realising the essential of environmental awareness among the students, subjects on environment have been integrated in the syllabus of the programme as one of the main subjects. However, this programme is amended to a 5 year programme and will be implemented from May 2002. This is to fulfill the National Higher Institution Committee's new requirements where all educational programmes at higher learning institutions are changed from 3 to 4 years and 4 to 5 years respectively. Therefore this study aims at

i) investigating the course structure of the B.Sc. (Remote sensing) 5 year programme with special attention given to the use of remote sensing technology for environmental analysis, and
ii) analysing in detail the integration of environmental elements in the programme.

2 DEPARTMENT OF REMOTE SENSING

DRSUTM was established in July, 1998. However, RS technology has been implemented since 1986 through the establishment of the Centre for Remote Sensing (CRS). CRS provides RS education, facilities to carry out research,consultation services and training. Now, the department consists of 9 full- time lecturers, 2 tutors and three laboratory assistants. The course is also supported by lecturers from other departments like Geomatics and Geoinformatics. Student intake began in May 1997 with the intake of 28 students. Currently introductory and advanced level RS and GIS are taught to 123 students from year one to four. The first batch graduated in July 2001.

3. CURRICULUM OF THE PROGRAMME

Why 5 year programme?

a). The 5 years programme will booster EE because subjects on environment have been diversified, covering many areas of geography, oceanography, atmospheric science, exploration of space science, sustainable development, field data collection, natural resources management, meteorology, hydrology and water resources, and natural hazards management (Table 2 and Table 3).
b). The duration of students' industrial training and RS camp have been extended from 2 months to 6 months (with 12 credits) and from 2 weeks to 3 weeks respectively. The extended period will enhance students' skill at particular area being trained.

c). The availability of high resolution satellite data attracts corporate sectors in Malaysia to use RS and related technologies in their projects. Thus, the extended study period of 5 years will provide skillful RS specialists to fulfill the ever-increasing demand for RS specialists.

4. COURSE STRUCTURE

The course structure and the curriculum of 5 years B.Sc. (RS) programme was amended and prepared by the Faculty of Geoinformation Science and Engineering upon the consent of various institutions and RS and space related industries both in Malaysia and overseas. A total of 159 credits are needed to fulfill the requirements to be awarded the degree of B.Sc. (RS). The credits come from 4 categories of subjects (Table 1). The study period for the new programme is 10 semester (5 years) and maximum allowed study period is 12 semester. The curriculum of the programme is shown in table 2.

Subject categories	*Credits*	*Percentage*
Core	101	63
University	20	13
Basics	26	16
Elective	12	8
Total	159	100%

Table 1. List of subjects based on categories

The old and also the new curriculum are formulated in such a manner that it could foster the development of critical thinking and problem solving skills in environmental related problems. The curriculum addresses a diverse range of environmental topics (Table 2). According to Table 1, environmental subjects are emphasized in core subjects where 25 credits off 101(25%) are allocated for these subjects.

5. INTEGRATION OF ENVIRONMENTAL ELEMENTS AND TEACHING APPROACHES IN THE COURSE

The environmental subjects taught to the students are divided into two modules: concept/theory and training/applications. This division is expected to integrate components of EE proposed by EPA in 1999:

(i) Awareness and sensitivity to the environment and environmental challenges
(ii) Knowledge and understanding of the environment and environmental Challenges
(iii) Attitudes of concern for the environment and motivation to improve or maintain environmental quality and
(vi) Skills to identify and help resolve environmental challenges

These components are channeled through the following approaches:

i) Principles of direct experience, ii) Responsible action, iii) Consequences of action, vi) Aesthetic appreciation and v) environmental ethic.

Sem.	Code	Subjects	Sem.	Code	Subjects
I	UHB1312	Proficiency Skill In English	**II**	UHB1322	English for Academic Communication
	ULT1012	Islamic civilization & Asian civilization (Paper I)		UHP1132	Malaysian Nationalism
	SSM1173	Mathematics 1		SGS1622	Introduction to Space Science
	SSF1033	Physics 1		SSM1273	Mathematics 2
	SSF1801	Physics (lab) 1		SSF2033	Physics 2
	SGS1513	Remote Sensing Technology 1		SSF2801	Physics (lab)2
	SGS1523	Programming & Computer concepts		SGS1613	Surveying & Mapping 1
		Total Credits (17)			**Total Credits (16)**
III	UHB2332	English for Professional Communication	**IV**	UHP2142	Islamic civilization & Asian civilization (paper II)
	ULT2032	Islamic institutions		UQ_1__1	Co-Curriculum *
	SGS2512	*Bio-geography & Geo-chemistry*		SGS2613	Surveying & Mapping 2
	SGS2522	*Physical Geography & Oceanography*		SGS2623	Geographical Information System 1
	SGS2533	Photogrammetry 1		SGS2633	Computer Programming
	SGS2543	Statistics 1		SGS2643	Statistics 2
	UQ_1__1	Co-Curriculum *			**Total Credits (15)**
		Total Credits (15)	**VI**	UHP3**2	UHP Subjects– Elective
V	ULT3**2	ULT Subjects– Elective		SGS3613	Satellite Technology & Earth Station
	SGS3513	Surveying & Mapping 3		SGS3623	Photogrammetry 2
	S0GS352 3	Remote Sensing Technology 2		*SGS3633*	*Field Data Collection*
	SGS3533	Cartography		*SGS3643*	*Remote Sensing for Environment*
	SGS3543	*Atmospheric Science*		SGS3653	Micro Wave Remote Sensing 1
	SGS3553	Digital Image Processing 1		*SGS3601*	*Remote Sensing Camp (3 Weeks) HW*
		Total Credits (17)			**Total Credits (18)**
VII	SGS4513	Digital Image Processing 2	**VIII**	SGS4619	Industrial Training 6 months
	SGS4523	'Spatial & Temporal' Data Base		SGS4623	Industrial Training Seminar & Report
	SGS4533	*Remote Sensing for Earth Resources*			**Total Credits (12)**
	0SGS454 3	Satellite System & Remote Sensing Data Delivery	**X**	SGS5612	Policy & Legal Aspects of Remote Sensing
	SGS4553	Geographical Information System 2		SGS5623	Remote Sensing Project Management
	SGS4563	Technical Writing		SGS5634	Undergraduate Project 2
		Total Credits (17)		*SGS56_3*	*Elective 3*
IX	SGS5513	Photogrammetry 3		*SGS56_3*	*Elective 4*
	SGS5523	Spatial data Analysis			**Total Credits (15)**
	SGS5533	Digital Image Processing 3			**SUM OF TOTAL CREDITS (159)**
	SGS5542	Undergraduate Project 1			
	SGS55_3	*Elective 1*			
	SGS55_3	*Elective 2*			
		Total Credits (17)			

Table 2. Subjects and the corresponding credits for the B.Sc. (Remote Sensing) course at UTM. Shaded rows indicate the environmental related subjects.

UHB, UHP, ULT, UQ = University's general subjects, *SSM, SSF, SGS* = Basic Subjects and *SGS* = Core subjects/elective subjects

Elective subjects *4 subjects*	***Semester IX (any 2 subjects)***		Credits
	SGS5553	Environmental Impact Assessment	3
	SGS5563	Microwave Remote Sensing 2	3
	SGS5573	Satellite & Sensor Design	3
	SGS5583	Remote Sensing for Meteorology	3
	Semester X (any 2 subjects)		
	SGS5653	Remote Sensing Hydrology & Water Resource	3
	SGS5663	Remote Sensing for Marine Applications	3
	SGS5673	Space Science Technology for Sustainable Development	3
	SGS5683	Remote Sensing for Environmental Conservation & Natural Hazard Management	3

Table 3. List of Elective subjects

The first and second components of environment are integrated via introducing the concepts of environmental systems, the complexity and inter-relatedness of natural systems and ways of achieving sustainability or equilibrium with and without the interference of human (through concept and theory module). This enables them to understand the complex system of the environment. The exposure towards the existing global environmental issues and the local and global policies and regulations of abatement will develop environmental concern among the students. Third and fourth components of skills to identify and help resolve environmental challenges and skills to identify and resolve environmental problems are achieved through the application/training module.

This module provides the students with practical skill that can be used to solve problems in the real world. Weekly laboratory exercises for environmental related subjects are designed to complement recent lecture topics in order to create a seamless teaching environment. The classroom training objectives for students include analysing remotely sensed data and applying GIS tools to address issues in natural resource management and environmental monitoring.

These components of environment are achieved via "principles of direct experience" method. This method provides a real world context for learning and linking the classroom to the needs of the community. In this context, real issues that impact every community are used as examples to embed the environmental awareness among students. Issues such as both drinking and other usable water quality, indoor and outdoor air quality, habitat improvement, solid and hazardous waste management, natural hazards or risk assessment and remote sensing as mitigating equipment for this issues are explored. Laboratory assignments are conducted using imagery from local regions so that students are familiar with the study sites and encouraged to conduct necessary ground truth. Besides that, students are also trained to use data collecting equipment like radiometer, hand held GPS, Nephelometer or boat for oceanographic applications.

Students of third year are also exposed to a 3 week "RS camp", an intensive practical exercise as part of the real environmental exploration. In this programme students are placed at places farther from the varsity for conducting environmental analysis using satellite imageries. For instance, the first batch students went to the East Coast of Peninsular Malaysia and exposed to marine applications of RS and related technologies. Whilst, the second batch students were brought to capital city of Kuala Lumpur and nearby new administration centre of Putra Jaya and Cyber Jaya. Here, the students conducted studies on issues like modes of transportation, problems arising from transportation and mapping the main routes using both RS and GIS techniques, issues of water pollution and linked the learnt techniques to collect data on pollution indicators, land use land cover mapping and etc.

In addition to that, the final year students in this course also participate in independent undergraduate projects which carry 6 credits towards the end of the semester. This requirement encourages students to experiment the learnt theory and remotely sensed imagery or GIS techniques to topics of personal interest to them. This exercise involves students moving away from textbook-driven, teacher-led instruction to 'hands-on", learner centered and cooperative learning approaches where students are actively engaged in their own learning process. In this way learners are encouraged to collect and scientifically analyse samples related to the topic of their interest. 93.5% of first batch undergraduate projects were related to exploration and resolving of environmental issues covering land applications (67.6%), marine applications of 19.4% and 6.5% of atmospheric studies. The rest 6.5% are related to pure digital image processing works.

DRSUTM has also arranged industrial training for students besides the classroom practical/ laboratory training. This industrial training is formulated to expose students to the aspects of RS, GIS and other related technologies and aspects of environment that are practiced in government departments and private sectors. This gives opportunity to students to experience the real working environment and to relate both the learning process and the real working environment.

SUMMARY

Integration of RS technology into EE is an effective way to promote environmental awareness among students and produce environmentally friendly citizens. RS is a new, rapidly growing and digital in nature technology certainly will attract community especially students to learn more about the technology and apply it to explore and find solutions to many emerging environmental issues. The new (5 years) programme is different from the 4 years programme that the number of subjects are increased from 34 to 46, and the total credits are increased from 130 to 159. Generally the new programme shows 25% increase in curriculum. Thus, the B.Sc. (RS) is a new and efficient programme in Malaysia to embed environmental awareness using high technology among Malaysians.

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