UPM Inaugural Lecture Series

ACTIVATING SCIENCE TEACHERS' KNOWLEDGE AND LIFELONG JOURNEY IN THEIR PROFESSIONAL DEVELOPMENT

Prof. Dr. Kamariah Abu Bakar

Diterbitkan di Malaysia oleh
Bahagian Komunikasi Korporat
Universiti Putra Malaysia
43400 UPM Serdang
Selangor, Malaysia

Tel : 603-8946 6003
Fax : 603-8948 7273
e-mail: cco@admin.upm.edu.my

ISBN 967-960-203-6

INAUGURAL LECTURE

PROF. DR. KAMARIAH ABU BAKAR

ACTIVATING TEACHERS' KNOWLEDGE AND LIFELONG JOURNEY IN THEIR PROFESSIONAL DEVELOPMENT

3 March 2006

DEWAN TAKLIMAT
TINGKAT 1, BANGUNAN PENTADBIRAN
UNIVERSITI PUTRA MALAYSIA

KAMARIAH ABU BAKAR

Professor Dr. Kamariah Abu Bakar was born in Segamat, Johore, where she grew up and obtained her initial primary education. Subsequently, she completed her primary and secondary education in Batu Pahat. Born to a family of teachers, she also pursued the profession and obtained the Certificate of Education specializing in Chemistry and Biology. She then taught for four years during which time she married Radzuan Abdul Rahman. While accompanying Radzuan when he was pursuing his degrees at Cornell University, Ithaca, U.S.A., in January 1972, Kamariah pursued her B.Sc. degree majoring in Science Education at the State University of New York, College at Cortland, and graduated in August 1974. A year later she completed her Masters degree in Science Education, at the same university and reported for duty as a lecturer at the then Faculty of Educational Services, Universiti Pertanian Malaysia, presently known as Faculty of Educational Studies, Universiti Putra Malaysia (UPM), on 27th December 1975, thus marking the beginning of her career in the academe as a science teacher educator and researcher. Late 1980, she left her family for Southern Illinois University, Carbondale for her Ph.D. and succeeded, in 1984 in defending her dissertation. In 1985 she was conferred the Doctor of Philosophy in Science Education by the university. In 1991, she was promoted to Associate Professor, and in 2001 to Professor.

Professor Dr. Kamariah Abu Bakar has dedicated about 30 years of her life in pursuing Science Education as a teacher and a teacher educator. Besides teaching, she also has a wide experience in student supervision, research and consultancy, and administration. Her current teaching revolves around Science Education and the academic use of Information, Communication and Technology (ICT) in education, more specifically in Science and Chemistry methods courses, teaching-learning strategies, research designs in education for undergraduate and graduate level. Throughout her career, she has taught thousands of secondary school students, undergraduates and graduates, some of whom are now associate professors and senior lecturers at the university level. She has supervised hundreds of student teachers and more than 50 graduate students at the master's and doctoral levels as well as served as internal and external examiner to post graduate students' theses. To date she has been involved in 30 research in her area of interest some of which are projects as consultancy research undertaken for the Ministry of Education. One of the research projects was conducted at University of Iowa, Iowa City, U.S.A. after she was able to secure a Fulbright Scholar scholarship for her sabbatical in 1996. She had also been involved for about 20 years as resource person to the Science Unit, Curriculum Development Centre, Ministry of Education. So far, she has written individually or as a co-writer of about 150 articles and 12 books pertaining to science, science education, IT in education and many other aspects of education, in general.

Being a pioneer lecturer at the Faculty which was established in 1975, she has held various administrative posts, including being appointed in 1988 as Deputy Dean of Academic Affairs. She was the first lady administrator being entrusted with such a post at that time,

at U.P.M. for two terms. The second reappointment was in 1997. She resigned from the post after being appointed as the Director of the then Multimedia Instructional Design Centre, U.P.M. In 1998, while holding the post of Director, she was appointed as the Dean of the Faculty of Educational Studies for two terms. She relinquished the post of Director when the Centre merged with the Cyber Creative Laboratory to form the Institute of Multimedia and Software, UPM in 2001, of which she is still a Fellow.

Presently, Professor Dr. Kamariah Abu Bakar's expertise has been sought after as an External Assessor with the Universiti Sains Malaysia's Bachelor of Science with Education programme. Her expertise has also been sought after to give exposure to UPM's academic staff in regard to the techniques of instruction when she was made an Academic Associate of the Centre of Instructional Services, UPM, and as an experienced staff of the Faculty. Besides giving tutelage to UPM staff at the Main Campus, she had also presented to staff of UPM Bintulu Campus, and other organizations such as Yayasan Pelajaran Mara, Taylor's College, Kolej Kurniawan, Pusat Teknologi dan Pengurusan Lanjutan and Bureau Tatanegara.

Recognizing her contributions to the faculty and university, UPM had awarded Professor Dr. Kamariah Abu Bakar the Excellent Service Award in 1992, 1999 and 2001, and the Excellent Service Certificate for several years between the years mentioned.

Professor Dr. Kamariah Abu Bakar is married to Dr. Radzuan Abdul Rahman, now a corporate man, and they are blessed with two loving children Nur Aishah and Azman who is married to Sarinah Azis.

ACTIVATING SCIENCE TEACHERS' KNOWLEDGE AND LIFELONG JOURNEY IN THEIR PROFESSIONAL DEVELOPMENT

ABSTRACT

Human resource development is the backbone to a nation economic development. In fact the two are so intricately intertwined that it is safe to say that the higher the nation's level of technical know-hows and supremacy, everything else the same, the higher is its state of economic development and vice versa. The starting point of a nation's technical and scientific advancement is traceable to appropriate science teacher training programmes of the nation. In the case of Malaysia, although several changes have been made in the past to suit and reflect the needs of the country's technical manpower requirements, it is regrettable to note that thus far the desirable results have not been promising. It is contended that the major shortcoming lies in the less than effective professional development of science teachers inservice program practiced in the country. Lack of innovativeness of the programme and lack of ability to teach with passion amongst science teachers probably are major reasons for this. Against this background and in an effort to activate the science teachers' knowledge and lifelong journey of continuous, school-based professional development, the SMIT TeReC portal was embarked allowing the science teachers the opportunities for networking and the sharing of on-line materials.

INTRODUCTION

Malaysia has undergone streams of educational reforms. Intertwined and embroiled in all the different educational reforms are the teachers. Any form of reformation will affect the teachers who will have to shoulder the burden of change and to ensure that each reformation follows through to achieve the vision of the reforms. These reform movements may singly and in combinations present complex challenges to teachers as individuals and as members of a wider professional community.

Among these teachers are the science teachers. Science teaching is a complex activity that lies at the heart of the vision of science education. Science education in Malaysia dates as far back as over a century ago.

BRIEF HISTORICAL DEVELOPMENT OF SCIENCE EDUCATION IN MALAYSIA

Evidence showed that the birth of science education development dates as far back as the 1823 with the establishment of Raffles Institution, an English school in Singapore, for the elites. At the Institution, science subjects such as astronomy, mechanic and botany were taught. In 1930, a science teacher expatriate who taught at Victoria Institute developed a four-year course for all students at the Institution. Nevertheless, the student population remained elitist. The goal of science education then was for the young generation to interpret the environment and natural phenomena. This led to the introduction of General Science to be examined in the Junior Cambridge Examination in 1932 (Norhayati Alwi, Kamisah Osman & Lilia Halim, 2002). It must be noted here during that time the education system was very selective and only students who passed the Malayan Secondary School Entrance Examination were allowed to advance into secondary level.

Throughout the pre-independence period, whatever changes in education in the then Malaya were subjected to the general objectives of the colonial authorities, following the British model. After the national independence, and with the emergence of the Education Ordinance of 1957 followed by the Education Act of 1961, the national education established was acceptable to the people of the nation and the nation saw the abolition of the Malayan Secondary School Entrance Examination (MSSEE). School leaving age was raised to 15 years, thus permitting automatic promotion throughout the primary and lower secondary levels, i.e. the emergence of a Malaysian educational system that was for all Malaysians from an elitist type of educationall system. The formulation of the Education Act of 1961 characterised many of the features of the present education system. School education was raised from nine years to eleven years.

In line with the nationalization overture, science education reformation followed suit. It started with the 1968 *Projek Khas* at the primary schools, a special programme conducted

for the purpose of improving science and mathematics achievement especially in the rural schools. The following year, Integrated Science for Secondary Schools was introduced progressively for Form I-III and this curriculum was based on the Scottish Integrated Science Syllabus. The introduction of this syllabus was to ensure students obtain the appropriate knowledge level and understand some basic principles of science, have good attitudes towards science and to develop practical skills in science. For this syllabus the most important aspect is *the way* to obtain the knowledge and not learning knowledge without knowing *how to* obtain it. The relationships between the science content and the students' daily life were implicitly suggested to be discussed in their classes, though not specifically stated as an objective to be achieved. Thus, teachers progressively failed to implement it. This curriculum was to be a terminal course for students who were not pursuing academic life beyond lower secondary education.

Subsequently, for those students who proceeded into the Arts Stream of the upper secondary, they had to take Modern Science for Malaysian Schools, a syllabus which was adapted from the Nuffield Secondary Science. Students who joined the Science Stream had to take the Modern Chemistry, Modern Physics and Modern Biology all of which were adapted from the Nuffield Chemistry, Physics and Biology O-Level curricula. The curricula used for the Lower and Upper Six classes were the pure Chemistry, Physics and Biology curricula modified from the Cambridge Examination Syndicate Syllabus (A-Level).

Another major reform was the implementation of New Primary School Curriculum (KBSR) which was first tried out in 302 schools then progressively implemented in all Year One classes starting on 1983. The implementation of Man and the Environment syllabus which was the result of the integration of several subjects like History, Geography, Civics and Science, had created a major setback for the teaching of science as a subject. Primary school teachers were then reported as shying away from teaching the 'science' component of the subject due to insecurities and lack of confidence of these teachers in the science content, preferring to expand more on the other components of the subject. This major setback was only corrected with the reinstatement of Science as a subject in 1994 to arrest the decline on students' understanding of science.

By 1989, when students who had undergone the New Primary School Curriculum entered the secondary school, the educational system implemented the Integrated Secondary School Curriculum (KBSM). Integrated education is a strategy to relate the element of knowledge, skills, language and values into all subjects, including Science. In the process, it was hoped that the boundaries of discipline be softened. The National Philosophy of Education (NPE) was formulated in 1988, which further reinforce the direction and goals of education in Malaysia.

The latest reformation in education was triggered by the national address by the then Prime Minister, Tun Dr. Mahathir Mohamad in 1991. He had then outlined the future course for Malaysia. By the year 2020 Malaysia can be a developed country. For Malaysia

to achieve this status, the custodian of Malaysia's educational system, the Ministry of Education (MOE) launched the Education Development Plan 2001-2010 (Ministry of Education, 2003). It was cautioned then that weaknesses in the implementation and delivery of the current curriculum might hinder secondary school education from fulfilling the needs for a competency-based education such as the acquisition and mastery of higher generic skills, technology utilizations skills, ICT skills, and resource management skills. The MOE's challenge is to increase students' knowledge and skills as well as to mould their attitude in line with the K-economy in order for the nation to move from a production-based economy to a knowledge-based economy (K-economy) that emphasizes intellectual capital will require continuous human resource development and knowledge growth.

In line with this declaration and in order to ensure that the future generation will be able to compete in a knowledge-based economy, mastery of English as the International Language is most crucial. This led to the declaration by the then Minister of Education, on 20th July 2002, that Science and Mathematics were to be conducted in English, apart from the Bahasa Inggeris subject, to be implemented progressively in 2003 for Year 1, Form 1 and Lower Six classes, amidst protests of some short sighted groups. Thus, this most recent educational reform has placed a renewed emphasis on science pedagogical practices and the integration of technology in science.

SCIENCE EDUCATION

The aim of science education in the 1980's was to prepare individuals with scientific knowledge and scientific skills and at the same time to develop their intellectual thinking skills, while at the same time to inculcate in the individual's noble values. This is to ensure the students understand and appreciate the contribution of science and technology in their everyday life. This aim of science education may only be realized if students are actively involved and are given the opportunity to develop their critical and creative thinking skills.

Science curriculum of the 1990's is for the development of a progressive society which appreciates science and is forward looking, very competitive, and are not just a consumer of technology but also a contributor to the scientific and technological civilization. Thus, Malaysian citizens aspired by Vision 2020 are individuals who possess the ability to think critically and creatively and be problem-solvers and decision makers.

The aims of our Malaysian science education are in line with the purpose of teaching of science in schools as specified by Lederman & Niess (1997). They indicated that the important purpose of pre-college science is to educate individuals so that they can make valid judgements on the value of knowledge created by science and other ways of knowing, and to understand why the literature regards scientific knowledge as dynamic and not as absolute, but as tentative, empirically based, culturally embedded, and is the product of some degree of assumption, subjectivity, creativity, and inference. Understanding of

scientific knowledge and its relevance to everyday life is necessary for the development of citizens of tomorrow; citizens who need to understand science and technology. It is, therefore, important that students master the scientific knowledge through fun activities and that the activities are also meaningful and relevant to their everyday life. After all, Malaysians will have to understand and work competently with science on a daily basis in the future. If this is not maintained Malaysia is incapable of getting to be a global player. If science is that important for the future of the world, shouldn't it be the then the 'S' of the '3R' – 3RS?

TEACHER EDUCATION

In line with the Malaysian National Philosophy of Education, the Philosophy of Teacher Education in Malaysia is an on-going effort towards producing teachers who are of high moral standards, who possess progressive and scientific vision, who are committed to uphold national aspirations and cultural heritage, who ensure the development of individuals, and who preserve a united, democratic, progressive and disciplined society (Kementerian Pendidikan Malaysia, 2001). With this as the philosophy, the conceptual model of teacher education was mooted.

The Conceptual Model Of Teacher Education

The Conceptual Model of Teacher Education is based on the Philosophy of National Education (PNE) and the Philosophy of Teacher Education (PTE) which emphasise the importance of the fundamental aspects of education: knowledge, skills and values, which is integrated across all subject discipline and programmes as shown in following the diagram (Kementerian Pendidikan Malaysia, 2001).

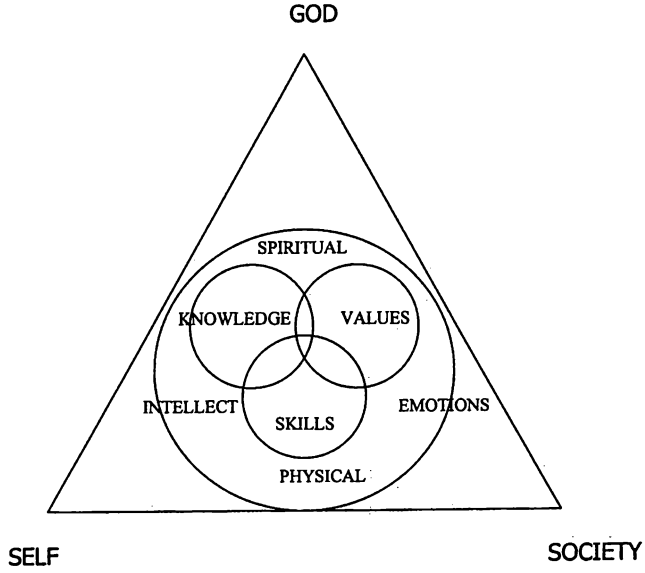


Figure 1: Conceptual Model Of Teacher Education

For purposes of clarity, the above conceptual model is rooted on placing teacher's accountability in three main dimensions: God, Self and Society. Accountability to God means a teacher is to promote the acquisition of knowledge in an individual, to internalize and to practice, as a human being with a belief in and adherence to religious teachings. Accountable to 'Self' ensures the building of resilience and patriotism, instilling the culture of knowledge and the shaping of personality and good character of an individual. As a member of a society, a teacher is also to emphasise on the role of a teacher as an educator, a leader and an agent of change. All in all, this model emphasizes on developing the potential of individual in a balanced and holistic manner by integrating the spiritual, emotional, intellectual and physical aspects. This aspiration will be achieved through the implementation of the teacher education curriculum, which integrates the various aspects of knowledge and pedagogical skills and values (Kementerian Pendidikan Malaysia, 2001). Currently, MOE in its quest to ensure that 100% of teachers teaching at the secondary schools, and 50% of teachers teaching at the primary schools are graduates by 2010, has shelved its Malaysian Teaching Diploma Courses (KDPM). Only courses related to the Post Graduate Diploma in Teaching (KPLI) are being conducted at the Teacher Training Colleges; and the special twinning programme between certain Teacher Training Colleges and the Faculty of Education of public universities called Graduate Teachers Conversion Programme i.e. Program Khas Pensiswazahan Guru (PKPG) are in full swing. In the pipeline is the development of the Institut Pendidikan Guru (Teacher Education Institute) under the Teacher Education Division of the MOE. All in all, about 27 of the teacher training colleges will progressively and eventually make up this Institute. As of 30th June 2005, the number of teachers in Government and Government-assisted primary and secondary schools in Malaysia are illustrated in the following table. Approximately 24,000 secondary school teachers (about 18%), and about 179,00 primary school teachers (about 94%) have yet to be graduate teachers.

Table 1: Number of Teachers in Government and Government-assisted Primary and Secondary Schools in Malaysia as of 2005

Level	Category	Number	Percent
Primary School	Graduate	11,539	6.06
	Non graduate	163,353	85.82
	Untrained	15,444	8.11
	TOTAL	**190,336**	**100**
Secondary School	Graduate	112,578	82.42
	Non graduate	21,127	15.47
	Untrained	2,893	2.12
	TOTAL	**136,598**	**100**

(Source: Ministry of Education Malaysia, 2005 (extrapolated)

The curriculum of Post Graduate Diploma in Teaching is designed to interpret the three aspects of education, that is knowledge, skills and values, in an integrated manner. The knowledge component, encompasses the general knowledge and the content knowledge of specialised subject matter. This includes the knowledge of KBSR, KBSM as well as professional pedagogical skills. The skills component encompasses professional knowledge which aims towards developing communication, thinking, information technology and pedagogical skills. The formation of the 'how-to' aspects in teaching and learning, and the reinforcement of it, focus on the integration of information technology in the implementation of the curriculum. The values component refers to the formation and practice of positive values and qualities befitting a teacher, such as being caring, noble, resilient, patriotic, innovative, creative, competent, of high credibility and committed to the profession (Kementerian Pendidikan Malaysia, 2001). Since this is a one-year Post Graduate Diploma in Teaching programme, it becomes a favourite programme especially for unemployed or underemployed graduates, and those picking up a new trade. It may also provide avenues for people who suddenly start to like the teaching profession later in their career path.

Apart from the programme carried out at the teacher training colleges, several public universities are running the Bachelor of Education in an array of field of specializations and the Bachelor of Science with Education courses, majoring or minoring in combinations of Chemistry, Biology, Physics, or Science. All these programmes are four-year programs with total credits ranging from 128-132.

SCIENCE TEACHER PREPARATION

The Malaysian National Science Education Philosophy states that....

> 'In consonance with the National Education Philosophy, science education in Malaysia nurtures a Science and Technology Culture by focusing on the development of individuals who are competitive, dynamic, robust and resilient and able to master scientific knowledge and technological competency.'
>
> (Ministry of Education, 2002; pg. ix)

Towards this goal, all science teacher training institutions have the responsibility to ensure that all science teachers trained have the quality to spearhead the nation into becoming a knowledge society and a competitive player in the global arena. There is the need for competency-based education such as acquisition of science concepts and principles, and mastery of the scientific and higher generic thinking skills, ICT skills, technology utilizations skills, and resource management skills be accomplished.

USA as a nation had developed their National Science Standards as a guideline for the decentralized state-based curricula currently being implemented in the country. Towards

this goal, their National Science Teachers Association had developed the Association's Standards for Science Teacher Preparation (1998) and based on the Standards specified, Duggan-Haas, Enfield, & Ashmann (2000) presented the Standards schematically as in Figure 2 (modified). Most of the components outlined in the standards are similar to the required components of science teacher training programmes in Malaysia. The common grounds are not surprising, since the purpose of science teacher training is for the development of science teachers to uphold the science education of each respective country. The schematic representation illustrates what are needed to ensure that the science teachers are able to professionally practice. However, in terms of the weight of treatment for each component and the decentralized state-based curricula used in USA, the model differs greatly from that used in the Malaysian arena. The treatment of EDU 3077: Methods of Teaching Chemistry, for example, though following the course outline as approved by the UPM Senate, merges and incorporates the components of this model for the preparation of group. This model could be applied in the training of all science-based teaching methods classes.

In order for science teachers to be able to professionally practice they need to be prepared in all the components of Science Teacher Preparation Model as in Figure 2.

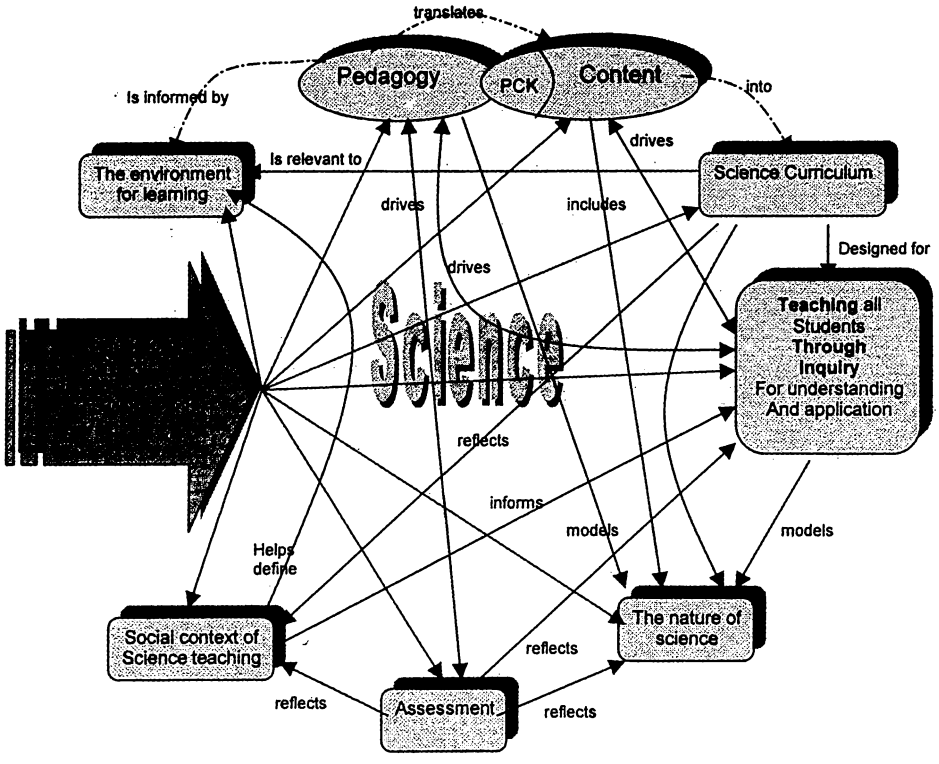


Figure 2: Science Teacher Preparation Model
(Modified from Duggan-Haas, Enfield, & Ashmann, 2000)

The training of science teachers is to prepare them to be able to teach science to students either at the primary or at secondary levels of the Malaysian schools. Briefly elaborating on the concept, science teacher training should prepare the science teachers for **professional practice** that requires them to be able to analyse the centralized **science curriculum** developed by the Curriculum Development Centre, Ministry of Education. Within each curriculum it has been specified the themes that act as the backbone of the curriculum. Specifications which include concepts, principles, the scientific skills, the scientific attitudes and noble values i.e. **content**, the **nature of science**, the learning outcomes to be achieved, the strategies to be utilized which also include the general **pedagogy**, the use of **inquiry**, the use of **social contextual learning** which also involve the Science-Technology and Society (STS) approach, are laid out. The role that **pedagogical content knowledge** (PCK) play is in synthesizing knowledge, pedagogical knowledge and the knowledge of context. All these components will in some way, be reflected in the **assessment**.

Science education programmes at teacher training college and university level have traditionally focused more on the acquisition of content than on developing skills in questioning and problem-solving. Mastery of the scientific knowledge and the development of understanding is crucial, for without grounded knowledge and understanding, teachers will not be able to teach clearly and make science more fun and meaningful to students. However, the development of skills in questioning and problem-solving is necessary in promoting science as an inquiry. Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world (National Research Council, 1996). The heart of inquiry is the ability to ask questions and identify solvable problems. Students in science should be given the opportunity to engage in inquiry early in their science programmes and should continue to inquire. The lack of focus on inquiring in their science education programmes may lead the science teachers into not having an inquiry mind. This may be observed since even at the graduate level students have been observed having a tough time towards the identification of a researchable question for their theses and dissertations.

In America, the National Science Teachers Association recommends that science teachers, apart from acquiring the scientific concepts and mastery of the scientific skills, need to acquire the abilities to listen and to ask effective questions during teaching; skills that are not easy for most people to master. Effective listening and questioning skills are important to successful teaching in general and need not be confined to science methods instruction. In fact, as for inquiry per se, core preparation in listening and questioning skills before science-specific preparation be the most effective and efficient approach to developing

these skills. However, the ability to ask questions that are consistent with the conventions and processes of science must be developed specifically.

The current reform effort requires a substantive change in how science is taught. Continued technological innovations are expanding the number of specialists in science. Even if a student is not destined for a career in a high technology, improved knowledge and understanding of science is crucial towards creating a workforce in every industry. Therefore, learning science is learning for the future to ensure a competitive workforce for the future. Thus, improving the science skills of our young people is an important step towards maintaining innovation-led economic growth. Thus, science teacher preparation must prepare our science teachers to be able to accommodate this reform.

It should be noted here that science teacher preparation must prepare the science teachers not only to be able to teach future scientists, but also to ensure that the citizens are scientifically and technologically literate. The reality is that scientific literacy and technology literacy are keys to Malaysia's economic growth, the future workforce, national security and more. These citizens are the ones who will be confronting unprecedented technological and ethical challenges in their lifetime. Also, while producing a more scientifically proficient citizenry, widespread science achievement will also increase the number of scientists and engineers who will drive future innovations.

Pedagogical Content Knowledge

Historically, knowledge bases of teacher education have focused on the content knowledge of the teacher. Traditionally, professional preparation of science teachers existed through the polarization of content and pedagogy. This occurred when potential science teachers learned pedagogy separately from the content or subject matter. Thus, most science teacher content knowledge comes from the disciplinary fields, while understanding of teaching comes from the field of education. Rather than viewing teacher education from the perspective of content or pedagogy, Shulman (1986) proposed a new framework for teacher education by introducing the concept of pedagogical content knowledge. Through the combination of the two knowledge bases of content and pedagogy, Shulman believed that teacher education programs would effectively prepare the teachers. Upon further development, Shulman and Grossman (1988) described pedagogical content knowledge as the knowledge formed by the synthesis of three knowledge bases i.e. subject matter knowledge, pedagogical knowledge, and the knowledge of context.

Pedagogical content knowledge is unique to teachers and this separates a science teacher from a scientist. Cochran, King and DeRuiter (1991) differentiated between a teacher and a content specialist i.e. a scientist not in the quality or quantity of their subject matter knowledge, but **in how that knowledge is organized and used**. Experienced science teachers' knowledge of science is structured **from a teaching perspective** and is **used as a basis for helping students understand specific concepts**. As for the scientist, a scientist's

knowledge is structured from a research perspective and is used as a basis for the construction and development of new knowledge in the field. On this matter, the original idea of the Faculty of Science, Universiti Putra Malaysia in the preparation of scientist cum teacher under the Bachelor of Science with Education program, on hind sight, may not have been a right move.

Pedagogical content knowledge has also been viewed as a set of special attributes that helped one to transmit the knowledge of content to others in the most useful forms by the use of powerful analogies, illustrations, examples, explanations, that is, the ways of representing and formulating the subject that make it comprehensible to others (Shulman, 1987). It also included those special attributes that teachers possessed that helped them to guide students to understand content in a manner that is personally meaningful. Further, it included how particular topics, problems, and issues are organized by adapting it to the variations in ability and the background of the learners, and presented during instruction.

Shulman (1987) also suggested that pedagogical content knowledge was the best knowledge base of teaching. It lies at the intersection of content and pedagogy, in the ability of a teacher to transform the content knowledge he or she possesses into forms that make sense to the students, hence pedagogically more powerful. However, pedagogical content knowledge fundamentally rests on thorough content knowledge and the skill to turn content knowledge to pedagogical content knowledge is the key to transforming a knower into being a teacher (University of Georgia, 2005). Thus, pedagogical content knowledge will differ by subject matter, developmental levels of learners, practitioners' understanding of the cultural experience and ways of making meaning that each learner brings to the learning community, as well as, the abilities those learners bring with them into the classroom.

Students undergoing a science teacher preparation programme should be provided with multiple opportunities to solve open-ended problems using appropriate scientific methods. These opportunities, though fundamental in their science methods preparation, should be present in their **science content courses**.

PROFESSIONAL DEVELOPMENT OF SCIENCE TEACHERS

Professional development for science teachers should be analogous to professional development for other professionals. To be an effective science teacher is a continuous process that stretches from the science teachers' preservice experiences in the undergraduate years to the end of their professional career path. Science has a rapidly changing knowledge base and expanding societal issues. Thus, science teachers will need ongoing opportunities to develop their knowledge, understanding, skills and abilities to keep pace with the continuously increasing and changing national agenda.

Professional development generally refers to ongoing learning opportunities available to teachers, through their schools, district, state or at the national level. Effective professional development is seen as increasingly vital to school success and teacher satisfaction. With schools today facing an array of complex challenges – from working with an increasingly diverse population of students, some with challenging social backgrounds, to teaching of science in English even if one's academic and professional background do not support this, to integrating new technology in the classroom, to meeting rigorous academic standards and goals set by the Ministry of Education, - continuous professional development on the part of the science teachers are deemed necessary. The question is how can this be done?

Using the analogy made by Owen (2004), Career development is more of a marathon than a sprint and requires individuals to change at almost every turn to fulfill their current role. Traditionally, professional development has been provided to science teachers through in-service workshops. Many teachers still receive the bulk of their professional development through some form of one-shot workshop.

Professional development plays an essential role in successful science education reform. Professional development serves as the bridge between where prospective and experienced science educators are now and where they will need to be to meet the new challenges of guiding all students in achieving higher standards of science learning and development. A bridge like professional development is a critical link between where one is and where one wants to be.

The current scene in professional development in no way resembles the ideal of a sturdy bridge to the science and technologically based future – a critical link that is supposed to be carefully and uniquely designed to meet particular needs of the nation. Instead, the professional development of science teachers experience is typically weak, limited since the courses are rather short, and fragmented, incapable of supporting them as they carry the weight to adequately prepare future citizens. Programs fall far short of helping teachers develop the depth of understanding they must have of science content, as well as how best to help their students to learn it.

This weakness in current professional development programmes for science teachers leads to many teachers entering the classroom unprepared to teach challenging science. Teachers' lack of preparation becomes even more critical in light of current demands of the science curricula. If teachers enter the classrooms not prepared or under prepared, for sure they will not be able to impart the science knowledge and skills in the best possible meaningful way. If they don't fully understand everything about what they are supposed to be teaching and the how to make the knowledge meaningful and interesting, then the science lesson can never be fun for the students. Again, if students do not fully understand what has been taught, science knowledge would be reduced to mere facts and due to lack of understanding, will be rote memorized, and may not even realize the relationship between the memorized facts and events that are happening around them.

Normally, professional development of science teachers are conducted during in-service, by the Curriculum Development Centre, or the State or District Education Offices, Ministry of Education. Based on over 20 years of observation, it has been observed that the type of professional development in most instances are very project-based, i.e. when there is a change in curriculum, for instance, then there would be a sudden frantic effort to train the teachers to suit whatever changes that have been made. Since the actions are more retroactive, the training tend to be more fragmented and piece-meal-like. The model commonly used has been the cascading model, and this is not without its flaws. The cascading model, no doubt allows for multiple number of science teachers to be trained during a short time, but the watering down effect is without doubt the cause of the science teachers, at the grass root level not being able to adopt the expected changes resulting in them going back to their comfort zone. Lately, the Curriculum Development Centre came up more prepared with booklets of whatever changes that needed to be changed in the new curriculum. However, if the science teachers at the grass root levels still do not understand and appreciate the content of these books, then they for sure would not have the confidence nor the passion to implement the reformation made. It has been said that notwithstanding all the reformations made to date, teachers continue to fall back on the 'old' methodology, even if it is deemed less effective. So, how is the nation supposed to build up a strong science based human resource to pursue future national scientific and technological developments?

Need Assessment

Professional development is a critical link between where one is and where one ought to be, based on the national requirements. Malaysia is undergoing through a period of accelerated change. The current changes in the Malaysian educational system require that science teachers address many issues that were not addressed when they were undergoing science teacher training. Some of these changes are in terms of:

1. the expanding content knowledge which the science teachers should be able to clearly articulate and relate to their students;
2. the nature of science to help their students make more informed decisions with respect to scientifically based issues;
3. inquiry where teachers should be able to demonstrate their understanding of the processes, tenets, and assumptions of multiple methods of inquiry to scientific knowledge and to engage their students to successfully engage appropriate inquiries that require them to develop concepts and relationships from their data;
4. issues related to science, technology and society which science teachers have to understand to help students to conduct inquiries into;
5. generic skills of teaching to ensure that their students with different backgrounds, abilities, needs, level of motivation and interests will be able to learn science, especially for those who are academically at risk;
6. developments in pedagogy which the teachers have to apply in imparting the content knowledge;
7. expansion of developments in information technology that require science

teachers to be equipped with not only the basic IT skills but also to be able to utilize and integrate IT in their teaching; and

8. mode of instruction since science is to be taught in English in all classes by 2007, a rather abrupt change in policy from the use of bahasa Melayu as a medium of instruction, posing extra challenges especially for teachers who learned the subjects in bahasa Melayu, and then further trained to teach in bahasa Melayu.

Assessing the gap between where one is and where one ought to be able to do, is usually done through needs assessment. To date, there was only one needs assessment of science teachers performed at a national level (Kamariah, 1984; Kamariah & Rubba, 1985) in which she compared the perceived needs of secondary science teachers against the needs of these teachers perceived by science teacher educators. Comparisons of perceived need were also made based on six different syllabi, based on number of years teaching experience, and based on states in the Peninsular. A total of 1162 science teachers were involved in the study. The results of this research was further compared with another research on science teachers in Jordan (Kamariah, Rubba, Tomera & Zurub, 1988). The results showed that for both developing countries, the science teachers perceive their most prominent needs are for self-improvement. This result is further supported by another research on need assessment conducted ten years later, but done on teachers from Sekolah Menengah Kebangsaan Agama (Kamariah et al. 1994; Kamariah Abu Bakar & Rohani Ahmad Tarmizi, 1995; Kamariah Abu Bakar & Rohani Ahmad Tarmizi, 1996), which showed that 88% of the top 25 perceived needs were mainly for self-development. A decade later, with the advent of ICT, with the implementation of the smart school concept (Government of Malaysia, 1997) and implementation of the teaching of Science and Mathematics in English, another national level need assessment is deemed necessary.

PROFESSIONAL DEVELOPMENT FOR THE FUTURE

Malaysia cannot have educational excellence without excellent teachers. Teachers need to continuously equip themselves through teacher development programmes – this would enable them to constantly upgrade themselves so that they can effectively address the many varied issues that constantly emerge in science. While regular short courses are specific and intensive in nature, the wider motivation in teachers to keep them enthusiastic is to attend conferences where they are exposed to issues, ideas, debate and discussion on a multitude of areas while at the same time networking and forge strategic alliances should also be attended to. Teachers should take responsibility for their personal and professional development. They should be lifelong learners in order for them to be better prepared for the various challenges being bombarded upon them while educating their students. In order to foster the culture of lifelong learning and a passion for knowledge, an alternative to the professional development that do not require the science teachers to continually be away from schools, need to be developed.

Professional development of science teachers need to be continuous and on-going involving follow up and support for further learning – including support from sources external to the school that can provide necessary resources and new perspectives (National Partnership for excellence and Accountability in Teaching, 1998). The professional development investments must be tied as powerfully as possible to improvements in student learning. This connection will be most successful by focusing the content of teacher learning in relation to the curriculum of student learning (Sykes, 1999). This suggestion is in line with the findings of Kennedy (1998). Kennedy found that the greatest effect occurred when teachers were engaged with knowledge that was directly relevant to what students were learning. Towards this goal the inclusion of relevant materials online to be shared by the science teachers need to be emplaced.

Thus, to derive maximum benefit from this innovation, the science teachers would have to develop or reactivate their English language proficiency in order to teach their students and at the same time being able to access the wealth of information on the subject areas currently available in English texts. Additionally, the science teachers would need to develop the practical competence to deliver their subject matter in the language.
Mastering the English language is one of the ways that we can prepare our students for the k-economy and the globalised world – in our quest to become competitive globally. Mastering English language will add economic value to our resources. Students too need to use English to seek knowledge in their quest for personal and professional endeavours. ICT revolution and Internet development has further strengthen the position of English language as an international language.

The Government had allocated RM23.4 billion to the Ministry of Education in 2004 budget in an effort to ensure Malaysia responds well to the changing demands and requirements for a world-class education. Thus, in 2004, the Ministry of Education has provided teachers with 79,144 notebook computers and 66,685 LCD projectors. Teachers are given training to fully utilize the hardware and software, besides being provided with Self-Learning packages. This is as part of Ministry Of Education's commitment to empower and alleviate the teaching profession, investing heavily in enhancing the learning-teaching environment with state-of-art hardware and software – wired with broadband access.

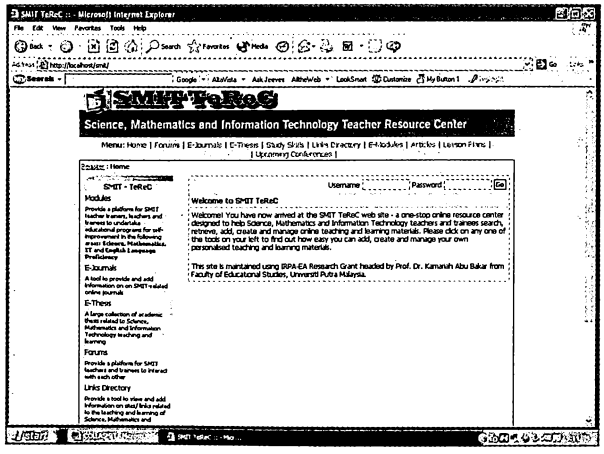
This is a national agenda. Thus, the Ministry of Education should not try to handle this alone. The Ministry needs to form partnerships with local universities, linking university expertise to schools, and collaboratively harness the Internet and all possible resources to assist the science teachers to develop professionally. For a learning community to be effective it must support engagement in part by giving the science teachers the opportunity to share their histories (Brosnan and Burgess, 2003), background, creative practices, successful solutions to problems with others who share the same outlook.

SMIT-TeReC PORTAL

Teachers need to continuously learn. They need to be continuously active. Lifelong learning conducted through non-formal channels such as virtual universities and distance learning, with knowledge and skills acquisition at all levels, must be promoted if the human resource capabilities of Malaysia is to constantly stay abreast of the new and rapid development of the global economy. Nevertheless, teachers in many parts of the world face numerous obstacles that contain them from being active in professional development, such as lack of time, insufficient up-to-date resources, materials and references. The Web with its capacity for creating connections and the sharing of resources, holds promise to host effective professional development programmes. Currently, although open learning is more readily available for teachers than ever before, with the advent of the Internet and the World Wide Web, there is still lack of online programmes geared towards teacher professional development, especially in the Malaysian context. Hence, there is a need to develop an online resource center for teachers in Malaysia, perhaps the region, to enhance their professional development. Towards this end Kamariah, Mohamed Amin and Affendi (2005) developed an educational portal for the professional development and lifelong learning of Science, Mathematics and IT teachers in Malaysia known as SMIT-TeReC.

SMIT-TeReC (see Picture 1) which is the acronym for Science, Mathematics and IT Online Teacher Resource Center can serve as a useful lifelong learning platform to help enhance these teachers' professional development. SMIT-TeReC is developed based on the concept of a one-stop teacher resource center and is accessible at http://www.smit.upm.edu.my

Indirectly, SMIT-TeReC, as other educational portals and online centers aim to achieve, strive on conglomerating an online community of practicing teachers. Research have suggested, and have been successful in indicating that the online communities are able to manage and attain the predetermined outcomes, and simultaneously foster collaboration among teachers. The components of SMIT-TeReC have the abilities to host a series of seminal online professional development experiences for Science, Mathematics and IT teachers, and it could also assist teachers in overcoming their problems related to professional development.



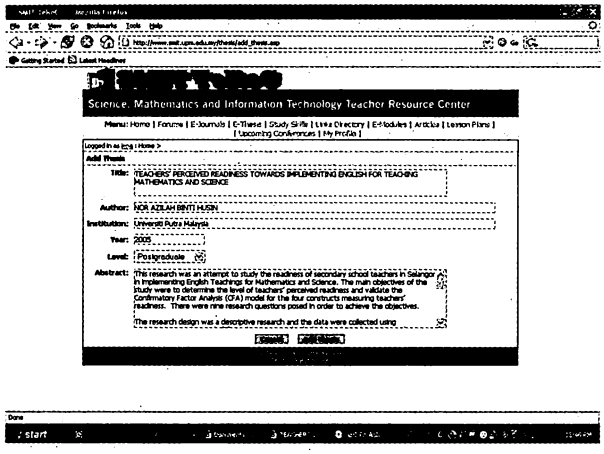
Picture 1: SMIT-TeReC Homepage

Van Fossen (2001) discovered that teachers rank reading professional journals and information gathering as the most common professional development activity. According to Gray (1999;120), WWW offers its user 'enormous opportunities for learning, including accessing information on formal educational courses, and collecting an unheard of wealth of data and information'. This huge amount of reading materials in the WWW is mainly in 5 forms: online magazines, online newsletters, online journal, web pages (or/and web sites) and resources centers. In relation to this, SMIT-TeReC hosts a database of online journals (see Picture 3) related to Science, Mathematics and IT learning and teaching and numerous links to resource center related to Science, Mathematics and IT learning and teaching.

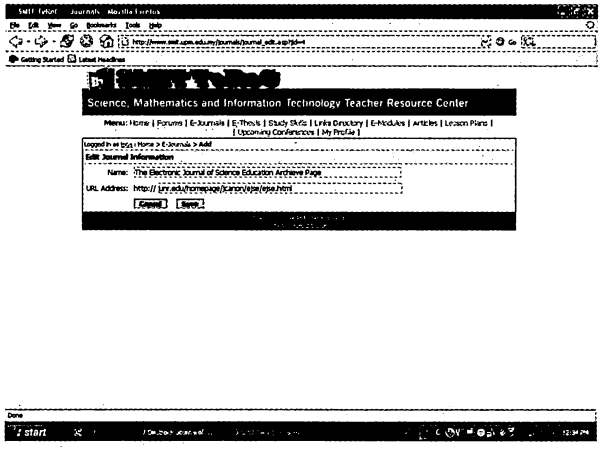
Online professional development, as perceived by Ellis and Renata (2000), challenges the traditional notions of academics working in isolation, and brings together teams of people each with unique contributions of skills to be made to course design, development and their delivery. It paves the way for new teaching and learning modes, which has never been practiced before such as ongoing maintenance and updating issues, students expectations of teaching staff, and more importantly the collaborative relationships. Ellis and Renata (2000:28) defined collaboration as 'a major tenet of action learning, with small teams or sets working together on tasks or problems'. McConnel (2000) too strongly advocated the use of computers, including the WWW, Internet, Computer-Mediated Communication, and IT, to facilitate cooperative learning amongst groups of people in formal learning and organizational situations. McConnel term this as Computer Supported Cooperative Learning (CSCL), and claiming it to have immense advantages and potentials to the training of individual.

In short, the Internet has the ability to provide educators the opportunities for networking with colleagues, learning about new developments as well as establishing a sense of community among teachers. Capitalizing on the idea of Knowledge Networking, SMIT-TeReC offers among others, the following professional networking tools for Science, Mathematics and IT teachers:

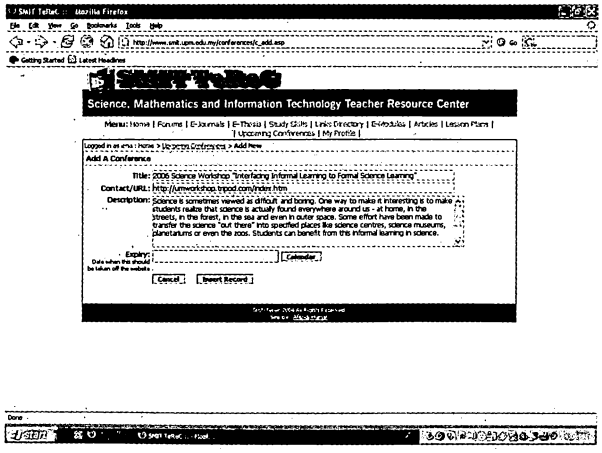
- E-Thesis - A tool for preservice and inservice teachers to view and add abstracts of undergraduate and postgraduate theses related to Science, Mathematics and IT teaching and learning (see Picture 2).
- E-Journals – A tool for Science, Mathematics and IT teachers to view and add information regarding online journals available for free on the Internet (see Picture 3).
- Upcoming Conference – A tool for Science, Mathematics and IT teachers to view and add information regarding upcoming conferences (Picture 4).
- Links Directory – A tool for Science, Mathematics and IT teachers to view and add information regarding Internet links (web sites) related to Science, Mathematics and IT teaching and learning.
- Lesson Plans/Tips – A tool for Science, Mathematics and IT teachers to view and add lesson plans on teaching the various subjects.
- Forum – An electronic discussion board that can be used by Science, Mathematics and IT teachers to exchange views on topics of similar interest (see Picture 5).



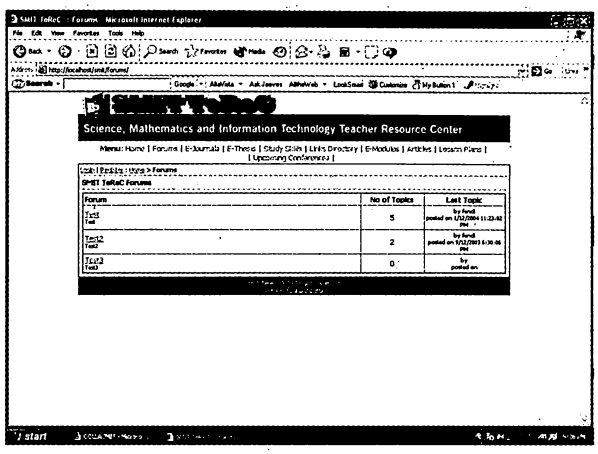
Picture 2: E-Thesis



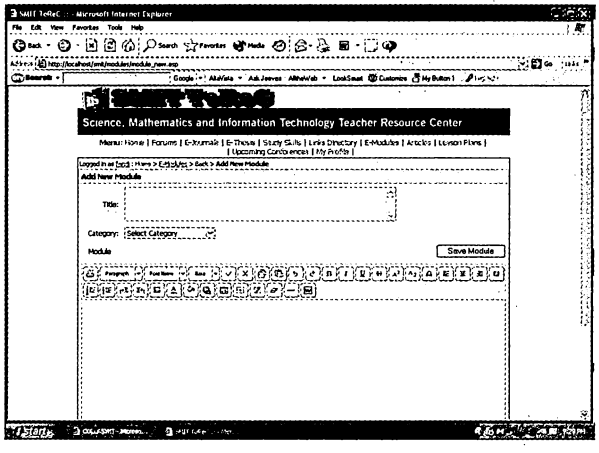
Picture 3: E-Journals



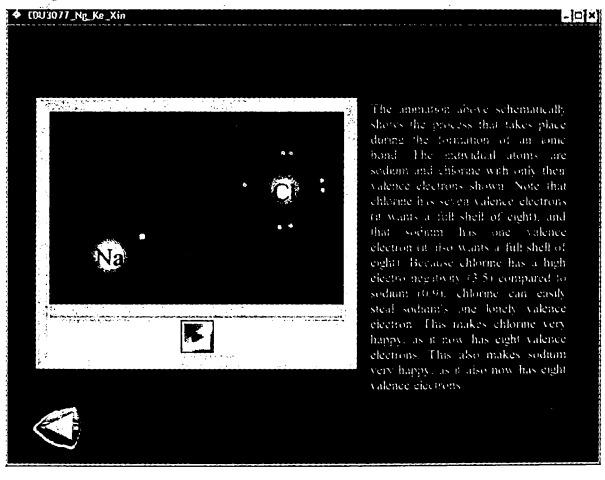
Picture 4: Upcoming Conference



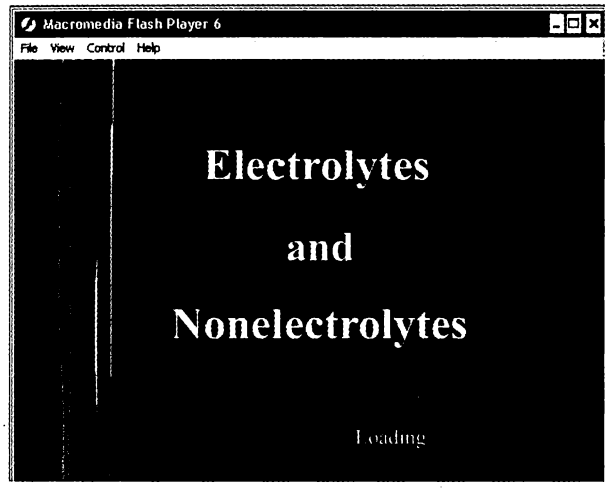
Picture 5: SMIT-TeReC Forum



Picture 6: Tool for Developing Online Modules



Picture 7: Example of Module 1



Picture 8: Example of Module 2

The above mentioned tools build and encourage the sense of belonging to a community of practicing teachers whereby each member of the community are able to support and help each other with the aim of becoming better educators. It also fosters a virtual friendship and togetherness, in a common struggle. Sharing and conferring are also themes of the developed tools, in which they bond teachers and help them and others to be more aware of the latest ideas and issues in Science, Mathematics and IT instruction, and at the same time reinforce and upgrade their existing knowledge.

As mentioned earlier, lack-of-time has often been the main factor inhibiting teachers to enhance their professional development. The Internet overcomes geographic boundaries and cuts time and financial constraints. SMIT-TeReC is designed also to offer self-access online learning modules for Science, Mathematics and IT teachers to enhance their professional development. The modules are developed using a tool known as e-Module (Picture 6) designed to allow enablers create, edit and publish online materials. Examples of pictures of modules are shown in Pictures 7 & 8.

What is novel about SMIT TeReC? The development of SMIT TeReC is an effort to create a platform that is user-friendly, a one-stop resource centre, providing an avenue for science, mathematics and IT teachers to share their creative ideas and best practices. A SMIT Journal is also being set up for these teachers and other interested parties, to share findings of their research with the community. In fact, SMIT-TeReC with its capabilities of enhancing Science, Mathematics and IT teachers' professional development, can be molded into an enjoyable place to submit, view and share joyful learning successes, which can act as the platform for activating science teachers' knowledge and lifelong journey in their professional development.

CONCLUSION

Effective science teachers professional development requires not only content modification relevant to the changing needs of the nation, but more importantly, to the changing need of the teachers themselves.

REFERENCES

Abdal Haqq (1996). Making time for teacher professional development. *ERIC Digest*, ED 400259

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* New York: Oxford Press.

American Association for the Advancement of Science. (1989). *Science for all Americans.* Washington DC: Author.

Bringelson, L. & Carey, T. (2000). Different (key) strokes for different folks: Designing online venues for professional communities. Educational Technology & Society, 3 (3).

Brosnan, K. & Burgess, R.C. (2003). Web based continuing professional development – a learning architecture approach. Journal of Workplace Learning. Volume 15, Number 1. pp. 24-33.

Duggan-Haas, D., Enfield, M. & Ashmann, S. (2000). Rethinking the presentation of the NSTA standards for science teacher preparation. *Electronic Journal of Science Education, V4* N3, available at http://www.msu.edu/~dugganha/rethink.htm retrieved 9/11/05.

Ellis, A. & Renata, P. (2000). Staff development for online delivery: A collaborative, team based action learning model. Australian Journal of Educational Technology, 16 (1), 26-44.

Government of Malaysia. (1997). The Malaysian Smart School: An MSC Flagship Application. Smart School Project Team.

Gray, T. (1999). The Internet in lifelong learning: Liberation or alienation? International Journal of Lifelong Education, 18 (2), 119-126.

Harris, R. & Niven, J. (2002). Retrofitting theory into practice – a reflection on the development of an e-learning community. Proceedings of the 3rd International Conference of Networked Learning. Sheffield University, 243-247.

Hishammuddin Tun Hussein. (2004). English as an alien language: Making sense of the extraterritorial and extraterrestial properties of the phenomenon in English language. Keynote address, by the Minister of Education at the 5th MICELT, 10th May 2004.

Joyce, G., Fisher, T. & Coyle, D. (2002). Developments in generative learning using a collaborative learning environment. Proceedings of the 3rd International Conference on Networked Learning, Sheffield University, 398-405.

Kamariah Abu Bakar, Mohamed Amin Embi & Affendi Hamat. (2005). SMIT-TeRec: Lifelong learning tool for science, mathematics and IT teachers; paper presented at theInternational Symposium on E-Learning (ISEL) 2005, organized by Universiti Malaysia Sabah, 25-26 July 2005.

Kamariah Abu Bakar & Rohani Ahmad Tarmizi. (1996). Professional developments of science and mathematics teachers of the National Religious Schools. Paper presented at the National Conference on Education of Religious Schools, Universiti Sains Malaysia.

Kamariah Abu Bakar & Rohani Ahmad Tarmizi. (1995). Teacher preparation concerns: Professional needs of science teachers. Paper presented at the Annual International Meeting, Charlston, W. Vitginia, January 5-8.

Kamariah Abu Bakar, Azizah A. Rahman, Sharifah Md. Nor, Rohani Ahmad Tarmizi, Abd. Majid Mohd Isa & Rosli Talif. (1994). Kajian keperluan profesional guru Sekolah Menengah Kebangsaan Agama dan Guru Pendidikan Islam Sekolah Menengah Kebangsaan. Laporan Penyelidikan anjuran Bahagian Pendidikan Islam, KPM.

Kamariah Abu Bakar, Rubba, P.A., Tomrts, A.N. & Zurub, A.R. (1988). Jordanian and Malaysian science teachers' prominent perceived professional needs: A comparison. *Journal of Research in Science Teaching, Vol. 25.* No. 7, pp, 573-587.

Kamariah Abu Bakar & Rubba, P.A. (1985). The constuct validity of the science teacher inventory of need: Recommendations and modificationd. *Educational and Psychological Measurement*, 45, (3) 699-704.

Kamariah Abu Bakar. (1984). A comparison of the perceptions of Malaysian secondary science teachers and teacher educators regarding the science teaching needs of Malaysian secondary teachers. A published dissertation submitted in partial fulfillment of a doctoral degree to the Department of Curriculum, Instruction, and Media, in the Graduate School, Southern Illinois University at Carbondale.

Kementerian Pendidikan Malaysia. (2001). Kursus perguruan lepasan Ijazah (KPLI), Sukatan pelajaran. Post Graduate Diploma in Teaching Science (Major), Kuala Lumpur: Bahagian Pendidikan Guru.

Kennedy, M. (1998). The relevance of content in inservice teacher education. Paper presented at the annual meeting of the American Educational Research Association, San Diego, CA.

Lederman, N.G., & Niess, M.L. (1997). The nature of science: Naturally? *School Science and Mathematics, 97*(1), 1-2.

Mahathir Mohamad (1991). Malaysia: The Way Forward, Kuala Lumpur: Malaysian Business Council.

McConnel, D. (2000). Implementing computer supported cooperative learning. London: Kogan Page Limited.

Ministry of Education Malaysia. (2005). Malaysian Educational Statistics 2005. KualaLumpur: Educational Planning and Research Division.

Ministry of Education Malaysia. (2003). Education Development Plan 2001-2010: Generating Educational Excellence Through Collaborative Planning. KualaLumpur: Educational Planning and Research Division.

Ministry of Education. (2002). Integrated Curriculum for Secondary Schools, Curriculum Specifications, Science Form I. Kuala Lumpur: Curriculum Development Centre.

National Partnership for excellence and Accountability in Teaching. (1998). Improving professional development: 8 research-based principles. Washington, DC: Author.

National Research Council. (1996). *National science education standards*. Washington DC: National Academy Press.

NCIHE. (1997). Higher Education in the learning Society – Report of the National Committee of Inquiry into Higher Education (Dearing Report), HMSO, London.

Norhayati Alwi, Kamisah Osman & Lilia Halim. (2002). GP20300: Perancangan Kurikulum Pendidikan Sains. Kuala Lumpur: Universiti Terbuka (Open University) Malaysia.

Owen, G. (2004). Mind the gap!: The critical role of continuing professional development. *Development and Learning in Organizations, Vol. 18*, No. 3, pp. 7-9.

Shaw, M. & Green, H. (1999), Continuous professional development: emerging trends in

the U.K. Quality Assurance in Education. Volume 7, Number 3, pp. 169-176.

Shulman, L. & Grossman, P. (1988). The Intern Teacher Casebook. San Francisco, CA: Far Wets Laboratory for Educational Research and Development.

Shulman, L.S. (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review, 57*(1), 1-22.

Shulman, L.S. (1986). Those Who Understand: Knowledge Growth in teaching. *Educational Researcher, 15*(2), 4-14.

Sujo de Montes, L. (1999). The use of Internet-based university courses as a tool for professional development of K-12 teachers. Unpublished Ed.D. Dissertation. New Mexico State University, United States.

Sykes, G. (1999). Spring. Make subject matter count. Journal of Staff Development, Vol 20, No. 2. Online at http://www.nsdc.org/library/publications/jsd/sykes202.cfm, retrieved on 9/12/2005.

University of Georgia, College of Education. (2005). PSC & NCATE Standards. http://ncate.coe.uga.edu/standards/standard1. retrieved on 9/10/2005.

Van Fossen, P. (2001). Degree of Internet/WWW use and barriers to use among secondary social studies teachers. *International Journal of Instructional Media, 28* (1), 57-74.

SENARAI SYARAHAN INAUGURAL

1. **Prof. Dr. Sulaiman M. Yassin**
   The Challenge to Communication Research in Extension
   22 Julai 1989

2. **Prof. Ir. Abang Abdullah Abang Ali**
   Indigenous Materials and Technology for Low Cost Housing
   30 Ogos 1990

3. **Prof. Dr. Abdul Rahman Abdul Razak**
   Plant Parasitic Nematodes, Lesser Known Pests of Agricultural Crops
   30 Januari 1993

4. **Prof. Dr. Mohamed Suleiman**
   Numerical Solution of Ordinary Differential Equations. A Historical Perspective
   11 Disember 1993

5. **Prof. Dr. Mohd. Ariff Hussein**
   Changing Roles of Agricultural Economics
   5 Mac 1994

6. **Prof. Dr. Mohd. Ismail Ahmad**
   Marketing Management: Prospects and Challenges for Agriculture
   6 April 1994

7. **Prof. Dr. Mohamed Mahyuddin Mohd. Dahan**
   The Changing Demand for Livestock Products
   20 April 1994

8. **Prof. Dr. Ruth Kiew**
   Plant Taxonomy, Biodiversity and Conservation
   11 Mei 1994

9. **Prof. Ir. Dr. Mohd. Zohadie Bardaie**
   Engineering Technological Developments Propelling Agriculture into the 21st Century
   28 Mei 1994

10. **Prof. Dr. Shamsuddin Jusop**
    Rock, Mineral and Soil
    18 Jun 1994

11. **Prof Dr. Abdul Salam Abdullah**
    Natural Toxicants Affecting Animal Health and Production
    29 Jun 1994

12. **Prof. Dr. Mohd. Yusof Hussein**
Pest Control : A Challenge in Applied Ecology
9 Julai 1994

13. **Prof. Dr. Kapt. Mohd. Ibrahim Haji Mohamed**
Managing Challenges in Fisheries Development through Science and Technology
23 Julai 1994

14. **Prof. Dr. Hj. Amat Juhari Moain**
Sejarah Keagungan Bahasa Melayu
6 Ogos 1994

15. **Prof. Dr. Law Ah Theem**
Oil Pollution in the Malaysian Seas
24 September 1994

16. **Prof. Dr. Md. Nordin Hj. Lajis**
Fine Chemicals from Biological Resources: The Wealth from Nature
21 Januari 1995

17. **Prof. Dr. Sheikh Omar Abdul Rahman**
Health, Disease and Death in Creatures Great and Small
25 Februari 1995

18. **Prof. Dr. Mohamed Shariff Mohamed Din**
Fish Health : An Odyssey through the Asia – Pacific Region
25 Mac 1995

19. **Prof. Dr. Tengku Azmi Tengku Ibrahim**
Chromosome Distribution and Production Performance of Water Buffaloes
6 Mei 1995

20. **Prof. Dr. Abdul Hamid Mahmood**
Bahasa Melayu sebagai Bahasa Ilmu - Cabaran dan Harapan
l0 Jun 1995

21. **Prof. Dr. Rahim Md. Sail**
Extension Education for Industrialising Malaysia: Trends, Priorities and Emerging Issues
22 Julai 1995

22. **Prof. Dr. Nik Muhammad Nik Abd. Majid**
The Diminishing Tropical Rain Forest: Causes, Symptoms and Cure
19 Ogos 1995

23. **Prof. Dr. Ang Kok Jee**
The Evolution of an Environmentally Friendly Hatchery Technology for Udang Galah, the King of Freshwater Prawns and a Glimpse into the Future of Aquaculture in the 21st Century
14 Oktober 1995

24. **Prof. Dr. Sharifuddin Haji Abdul Hamid**
Management of Highly Weathered Acid Soils for Sustainable Crop Production
28 Oktober 1995

25. **Prof. Dr. Yu Swee Yean**
Fish Processing and Preservation . Recent Advances and Future Directions
9 Disember 1995

26. **Prof. Dr. Rosli Mohamad**
Pesticide Usage: Concern and Options
10 Februari 1996

27. **Prof. Dr. Mohamed Ismail Abdul Karim**
Microbial Fermentation and Utilization of Agricultural Bioresources and Wastes in Malaysia
2 Mac 1996

28. **Prof. Dr. Wan Sulaiman Wan Harun**
Soil Physics: From Glass Beads To Precision Agriculture
16 Mac 1996

29. **Prof. Dr. Abdul Aziz Abdul Rahman**
Sustained Growth And Sustainable Development: Is there A Trade-Off 1~'or Malaysia
13 April 1996

30. **Prof. Dr. Chew Tek Ann**
Sharecropping in Perfectly Competitive Markets . A Contradiction in Terms
27 April 1996

31. **Prof. Dr. Mohd. Yusuf Sulaiman**
Back to The Future with The Sun
l8 Mei 1996.

32. **Prof. Dr. Abu Bakar Salleh**
Enzyme technology: The Basis for Biotechnological Development
8 Jun 1996

33. **Prof. Dr. Kamel Ariffin Mohd. Atan**
The Fascinating Numbers
29 Jun 1996

34. **Prof. Dr. Ho Yin Wan**
Fungi. Friends or Foes
27 Julai 1996

35. **Prof. Dr. Tan Soon Guan**
Genetic Diversity of Some Southeast Asian Animals: Of Buffaloes and Goats and Fishes Too
10 Ogos 1996

36. **Prof. Dr. Nazaruddin Mohd. Jali**
Will Rural Sociology Remain Relevant In The 21st Century
21 September 1996

37. **Prof. Dr. Abdul Rani Bahaman**
Leptospirosis - A Mode/for Epidemiology, Diagnosis and Control of Infectious Diseases
16 November 1996

38. **Prof. Dr. Marziah Mahmood**
Plant Biotechnology - Strategies for Commercialization
21 Disember 1996

39. **Prof. Dr. Ishak Hj. Omar**
Market Relationships in The Malaysian Fish Trade: Theory and Application
22 Mac 1997

40. **Prof. Dr. Suhaila Mohamad**
Food and its Healing Power
12 April 1997

41. **Prof. Dr. Malay Raj Mukerjee**
A Distributed Collaborative Environment for Distance Learning Applications
17 Jun 1998

42. **Prof. Dr. Wong Kai Choo**
Advancing the Fruit Industry in Malaysia: A Need to Shift Research Emphasis
15 Mei 1999

43. **Prof. Dr. Aini Ideris**
Avian Respiratory and Immunosuppressive Diseases - A Fatal Attraction
10 Julai 1999

44. **Prof. Dr. Sariah Meon**
Biological Control of Plant Pathogens: Harnessing the Richness of Microbial Diversity
14 Ogos 1999

45. **Prof. Dr. Azizah Hashim**
The Endomycorrhiza: A Futile Investment?
23 Oktober 1999

46. **Prof. Dr. Noraini Abd. Samad**
Molecular Plant Virology: The Way Forward
2 Februari 2000

47. **Prof. Dr. Muhamad Awang**
Do We have Enough Clean Air to Breathe?
7 April 2000

48. **Prof. Dr. Lee Chnoong Kheng**
Green Environment, Clean Power
24 Jun 2000

49. **Prof. Dr. Mohd. Ghazali Mohayidin**
Managing Change in the Agriculture Sector : The Need for Innovative Educational Initiatives
12 Januari 2002

50. **Prof. Dr. Fatimah Mohd. Arshad**
Analisis Pemasaran Pertanian Di Malaysia : Keperluan Agenda Pembaharuan
26 Januari 2002

51. **Prof. Dr. Nik Mustapha R. Abdullah**
Fisheries Co-Management: An Institutional Innovation Towards Sustainable Fisheries Industry
28 Februari 2002

52. **Prof. Dr. Gulam Rusul Rahmat Ali**
Food Safety: Perspectives and Challenges
23 Mac 2002

53. **Prof. Dr. Zaharah Binti A. Rahman**
Nutrient Management Strategies for Sustainable Crop Production in Acid Soils: The Role of Research using Isotopes
13 April 2002

54. **Prof. Dr. Maisom Abdullah**
Productivity Driven Growth: Problems & Possibilities
27 April 2002

55. **Prof. Dr. Wan Omar Abdullah**
Immunodiagnosis and Vaccination for Brugian Filariasis: Direct Rewards from Research Investments
6 Jun 2002

56. **Prof. Dr. Syed Tajuddin Syed Hassan**
Agro-ento Bioinformation: Towards the Edge of Reality
22 Jun 2002

57. **Prof. Dr. Dahlan Ismail**
Sustainability of Tropical Animal- Agricultural Production Systems: Integration of Dynamic Complex Systems
27 Jun 2002

58. **Prof. Dr. Ahmad Zubaidi Baharumshah**
The Economics of Exchange Rates in the East Asian Countries
26 October 2002

59. **Prof. Dr. Shaik Md. Noor Alam S.M. Hussain**
Contractual Justice in Asean: A Comparative View of Coercion
31 October 2002

60. **Prof. Dr. Wan Md. Zin Wan Yunus**
Chemical Modification of Polymers: Current and Future Routes for Synthesizing New Polymeric Compounds
9 November 2002

61. **Prof. Dr. Annuar Md Nassir**
Is The KLSE Efficient? Efficient Market Hypothesis vs Behavioural Finance
23 November 2002

62. **Prof. Ir. Dr. Radin Umar Radin Sohadi**
Road Safety Interventions in Malaysia: How Effective Are They?
21 Februari 2003

63. **Prof. Dr. Shamsher Mohamad**
The New Shares Market: Regulatory Intervention, Forecast Errors and Challenges
26 April 2003

64. **Prof. Dr. Han Chun Kwong**
Blueprint for Transformation or Business as Usual? A Structurational Perspective of The Knowledge-Based Economy in Malaysia
31 Mei 2003

65. **Prof. Dr. Mawardi Rahmani**
Chemical Diversity of Malaysian Flora: Potential Source of Rich Therapeutic Chemicals
26 Julai 2003

66. **Prof. Dr. Fatimah Md. Yusoff**
An Ecological Approach: A Viable Option for Aquaculture Industry in Malaysia
9 Ogos 2003

67. **Prof. Dr. Mohamed Ali Rajion**
The Essential Fatty Acids-Revisited
23 Ogos 2003

68. **Prof. Dr. Azhar Md. Zain**
Psychotherapy for Rural Malays - Does it Work?
13 September 2003

69. **Prof. Dr. Mohd Zamri Saad**
Respiratory Tract Infection: Establishment and Control
27 September 2003

70. **Prof. Dr. Jinap Selamat**
Cocoa-Wonders for Chocolate Lovers
14 February 2004

71. **Prof. Dr. Abdul Halim Shaari**
High Temperature Superconductivity: Puzzle & Promises
13 March 2004

72. **Prof. Dr. Yaakob Che Man**
Oils and Fats Analysis - Recent Advances and Future Prospects
27 March 2004

73. **Prof. Dr. Kaida Khalid**
Microwave Aquametry: A Growing Technology
24 April 2004

74. **Prof. Dr. Hasanah Mohd Ghazali**
Tapping the Power of Enzymes - Greening the Food Industry
11 May 2004

75. **Prof. Dr. Yusof Ibrahim**
The Spider Mite Saga: Quest for Biorational Management Strategies
22 May 2004

76. **Prof. Datin Dr. Sharifah Md Nor**
The Education of At-Risk Children: The Challenges Ahead
26 June 2004

77. **Prof. Dr. Ir. Wan Ishak Wan Ismail**
Agricultural Robot: A New Technology Development for Agro-Based Industry
14 August 2004

78. **Prof. Dr. Ahmad Said Sajap**
Insect Diseases: Resources for Biopesticide Development
28 August 2004

79. **Prof. Dr. Aminah Ahmad**
The Interface of Work and Family Roles: A Quest for Balanced Lives
11 March 2005

80. **Prof. Dr. Abdul Razak Alimon**
Challenges in Feeding Livestock: From Wastes to Feed
23 April 2005

81. **Prof. Dr. Haji Azimi Hj. Hamzah**
Helping Malaysian Youth Move Forward: Unleashing The Prime Enablers
29 April 2005

82. **Prof. Dr. Rasedee Abdullah**
In Search of An Early Indicator of Kidney Diease
27 Mei 2005

83. **Prof. Dr. Zulkifli Hj. Shamsuddin**
Smart Partnership: Plant-Rhizobacteria Associations
17 Jun 2005

84. **Prof. Dr. Mohd Khanif Yusop**
From The Soil to The Table
1 Julai 2005

85. **Prof. Dr. Annuar Kassim**
Materials Science and Technology: Past, Present and the Future
8 Julai 2005

86. **Prof. Dr. Othman Mohamed**
Enhancing Career Development Counselling and the Beauty of Career Games
12 August 2005

87. **Prof. Dr. Mohd Amin Mohd Soom**
Engineering Agricultural Water Management Towards Precision Farming
26 August 2005

88. **Prof. Dr. Mohd Arif Syed**
Bioremediation - A Hope Yet for the Environment?
9 September 2005

89. **Prof. Dr. Abdul Hamid Abdul Rashid**
The Wonder of Our Neuromotor System and the Technological Challenges They Pose
23 December 2005

90. **Prof. Dr. Norhani Abdullah**
Rumen Microbes and Some of Their Biotechnological Applications
27 January 2006

91. **Prof. Dr. Abdul Aziz Saharee**
Haemorrhagic Septicaemia in Cattle and Buffaloes: Are We Ready For Freedom?
24 February 2006