ACTIVE TEACHING AND LEARNING APPROACHES IN SCIENCE: TOWARDS A MODEL FOR MALAYSIAN SCIENCE EDUCATION

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One of the cornerstones of any nation's quest for development and success must be an effective education system that seeks to produce quality teaching and learning. This should be recognised as an investment in the nations' peoples and future. This paper intends to raise awareness of a current training programme aimed at developing Malaysia's science teachers' effective practice. The programme encourages constructivist classroom approaches and promotes active teaching and learning strategies in science. Data collected from the programme evaluation shows clear indications that participants who have been involved in the workshops to date, are highly enthusiastic towards the programme.

INTRODUCTION

Since gaining independence from Britain in 1957, the Malaysian government has sought a structured coherent education system which meets the needs of a multiethnic population while advancing the nation's capabilities as a fully developed, globally competitive country. 'Vision 2020' outlines the present government's commitment to achieving industrial and commercial success while investing in its peoples' potentialities. Underpinning this commitment is the realization that education has a critical role to play in achieving the kind of change and innovation required to succeed. The

introduction of the 1996 Education Act–*Seventh Malaysia Plan 1996-2000* (Government of Malaysia, 1996) has spawned a new outlook on Malaysian education with the provision of science and technology courses emphasized. Strengthening the teaching profession with qualified and experienced teachers is also high on the agenda alongside an aim to increase student enrolment in the science stream.

Also in 1996 (Ministry of Education, Malaysia, 1996) a project to encourage foreign universities to set up branch campuses in Malaysia with a view to sharing new ideas, promoting joint research programmes and enhancing teaching was established. Since 1999 The Centre for Science Education (CSE), Sheffield Hallam University (SHU) and SEAMEO RECSAM (South East Asian Ministers of Education Organization Regional Centre in Science and Mathematics) have been working in partnership to promote student-centred teaching and learning in science through ATLAS (Active Teaching and Learning Approaches in Science). Following a successful pilot training programme in the States of Penang and Sarawak in October 2000, the CCC (Central Curriculum Committee) agreed to a programme of training, proposed by RECSAM to take ATLAS across all fourteen states in Malaysia beginning in April 2001. The delivery of ATLAS to pre-service and in-service teacher trainers nationwide should enable effective dissemination to science teachers providing them with instructional enrichment, new ideas for teaching science and the opportunity to move away from traditional teaching philosophies.

If Malaysia is to succeed in its drive towards sustainable economic development an investment in an education system that promotes science and technology is crucial. Central to this is the development of a quality teaching profession which has strong pedagogical skills, classroom resources and a will to continuously develop. The ATLAS programme has a key role in helping to realize these cornerstones of Malaysia's vision.

PARTNERSHIP

In 1965 SEAMEO was established as an intergovernmental organization between governments of South East Asian countries with the aim of promoting cooperation in education, science and culture. RECSAM is one

of ten institutions charged with a mandate from SEAMEO, to achieve the following mission:

SEAMEO RECSAM is committed to nurture and enhance the quality of science, mathematics and technology education in SEAMEO member countries and beyond.

In line with this mission RECSAM offers a wide range of innovative training programmes and activities that address the needs of science and mathematics teachers and teacher educators throughout SEAMEO member countries.

The CSE is one of the UK's leading groups working on school science curriculum development. The Centre operates as a full cost business unit within SHU and has six programmes of activity:

1. Initial Teacher Training (ITT)
2. Teacher Continuing Professional Development (CPD)
3. Regional-community SET support
4. International development programmes
5. Activity-led research
6. Project development.

The CSE first established contact with RECSAM in 1998 in an attempt to promote ATLAS internationally following an invitation from the British Council in Malaysia to present ATLAS to key science education groups in Malaysia. The promotion of ATLAS came at a time when pedagogical thinking in Malaysia was moving away from the extreme end of teacher-centred instruction to that of student-centred approaches. The focus on students as active learners and teacher as facilitator, which underpins ATLAS is considered a more effective approach to teaching and learning that subsumes the more traditional knowledge transfer approach. The partnership is also supported significantly by the Shell Education Service and the British Council. These two organizations have been instrumental in supporting the development and promotion of this programme.

ATLAS

Two assumptions have guided the development of ATLAS since its conception in 1989 to the present. First, children learn best when they are motivated to learn–when they find the learning experience of worth and enjoyable, while actively involved in the process. Second, effective teaching is much more likely to emerge when a teacher has gained the confidence and skills to use a wide repertoire of strategies that provide a range of active learning experiences for students. Glaserfeld (1993) argues that:

> *"knowledge is always the result of a constructive activity, and therefore cannot be transferred to a passive receiver." (p. 24)*

ATLAS is grounded in a constructivist model of school science which builds on the proposition that school science should essentially begin with students' own constructions of what is real (Pines & West, 1986). Teachers working within such a paradigm encourage students to generate and make explicit their own ideas while challenging these ideas in an attempt to promote alternative interpretations (Driver & Bell, 1986). As a consequence, the knowledge transfer model currently employed within Malaysian classrooms ignores student constructions. Ten major characteristics highlight the active learning process and can be seen when students:

1. have personal involvement in their learning;
2. make decisions about the outcome of their work;
3. own their work;
4. test their own ideas;
5. plan and design their own experiments;
6. report their results to the rest of the class;
7. evaluate their results;
8. solve problems;
9. discuss and interact purposefully in groups;
10. reflect on the work they have done and reformulate their ideas.

Similarly active teaching can be defined by four characteristics and takes place when the teacher:

1. encourages student responsibilities for learning;
2. gets students to think for themselves;
3. offers a wide range of learning opportunities and strategies;
4. encourages any activities that lead to the active learning situations described above.

ATLAS aims to enable students to attain a higher level of understanding in science than with more traditional knowledge transfer models. By allowing students to realize a sense of ownership and personal involvement in learning they feel important and their ideas and suggestions are valued (Driver & Bell, ibid) thus, enhancing student satisfaction and motivation. Teachers are able to spend more time with individual students and small groups in the classroom while encouraging, assisting, advising and monitoring then. On a more pragmatic basis ATLAS can assist the monitoring and recording of student progress through the Malaysian science curriculum.

By utilizing strategies such as small group discussion, active reading, active writing, games simulations, role play, drama and problem-solving, ATLAS enhances students' potential for developing scientific skills such as:

1. planning;
2. hypothesising and predicting;
3. designing and carrying out investigations;
4. drawing inferences;
5. communicating findings.

These approaches also increase the potential for students to reflect on activities and investigations, which in turn aid their scientific understanding and the way the students reformulate their understanding in the light of new evidence.

THE PROGRAMME

The programme commenced in October 1999 with two 2-day training workshops delivered in Penang and Sarawak. Using the context of 'energy' forty-two science teachers and state officers were introduced to the underlying philosophy, principles and pedagogy, together with a range of active teaching and learning approaches focusing on:

1. active reading;
2. active writing;
3. group discussion;
4. experimental and investigative science; and
5. games and simulations.

The programme aimed to:

a) encourage collaborative learning;

b) promote student-centred teaching and learning;

c) use sustainable development contexts; and

d) equip students with the knowledge and understanding, investigative, problem-solving, and communication skills.

Workshop participants were encouraged to develop their confidence in using and developing the approaches, while increasing their ability to write curriculum materials grounded in the approaches. They were also encouraged to develop their ability to train other teachers in the approaches in an attempt to create a sustainable model of development.

Participants were given the opportunity to gain 'hands-on' experience of the approaches through the use of exemplar curriculum materials (on the topic of energy) supported by simple equipment. During workshops participants are encouraged to reflect on the value and suitability of the strategies, and how the approaches and exemplar materials may be adapted to suit their own classroom environments. Curriculum materials constitute a set of work cards and a box of equipment needed to run the activities with a full class of students. For example, toy cars, ramps and tape measures

for investigating energy changes from kinetic to potential energy. The kit enables teachers to teach all aspects of the topic of energy[1] using active approaches. Curriculum materials are aimed at upper primary and lower secondary sectors. Upon completion of the workshops teachers were able to take away and trial the teaching and learning approaches and curriculum materials in their own classroom.

In April 2000 a further series of workshops were delivered at RECSAM and in Sarawak. A new cohort of participants was introduced to the approaches from the original workshop as well as use of role-play and drama in science. Sarawak participants were able to use these approaches with groups of students enabling them to reflect on the suitability of the approaches with their own students. The original and new cohorts joined at RECSAM for a writing workshop aimed at re-drafting and developing the curriculum materials further. The materials, including teachers' notes were translated into *Bahasa Malaysia* in readiness for publication in the form of a teaching and learning package entitled 'Tenaga'–*Bahasa Malaysia* for 'Energy'. Tenaga was officially launched in September 2000 at RECSAM with a further ATLAS workshop that introduced forty State Education Officers, Ministry of Education staff, Curriculum Development Centre staff, and initial teacher trainers to the approaches and curriculum materials.

During this workshop the idea of producing a sustainable model of training and development was discussed in detail with a number of education officials which gave rise to the model of training that will, in future, focus on initial and in-service teacher trainers.

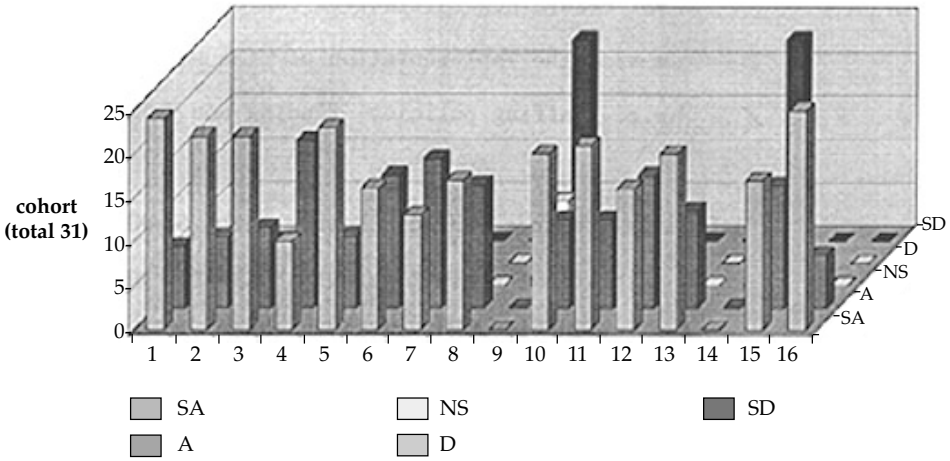
DATA

Data were collected from the workshops delivered in October 1999 and April/September 2000, through interviews with a selection of the workshop participants and from evaluation questionnaires (Appendix 1) completed

[1] Types of energy, energy change, energy changers, energy measurement, energy on the move, renewable and non-renewable sources of energy, energy decision making.

by workshop participants. Questionnaire data were analysed quantitatively and are shown in Table 1.

Table 1
Workshop Evaluation: RECSAM



Analysis of the interview data was completed in a qualitative approach through the NVIVO computer programme. Emergent themes were organised into five categories that focused on the participants' views of:

1. the science education provision in Malaysia;
2. science teaching in Malaysia;
3. Continuing Professional Development (CPD);
4. science students in Malaysia;
5. Active Teaching and Learning Approaches in Science (ATLAS).

Tables 2 to 4 identify the key themes that emerged from the interviews.

Table 2

Emergent themes concentrating on teachers' views of the science education provision in Malaysia

Emergent themes	
Incoherent strategies for the development of science education provision (piece-meal approach)	Education Ministry has not developed a clear strategy for science education in the past utilising an integrated approach which places science as a general subject with others, such as geography and history.
No prominence given to science	Until now science has been seen as a lesser career option in comparison with careers in the arts, medicine or law. Few graduates enter science teaching as a preferred career option.
Top-down system	Education Ministry operate a top-down approach to legislation–teachers are rarely consulted over new initiatives.
Poor transition from primary to secondary schooling	Primary science is now attempting to develop investigative science and associated skills, such as hypothesising and practical skills–secondary science still has a didactic emphasis on knowledge transfer and does not continue, fully, with the development of investigative science skills.
Experiments recipe-based; didactic instruction	More research-based investigations needed to enthuse and inspire students in science. Student-centred approaches, the way forward to achieve 'Vision 2020'.
Lack of resources/facilities	Inadequate laboratory equipment, outdated text books.
Large class sizes	Class sizes in secondary schools are frequently between 40-60 pupils which inhibits effective student-centred teaching.

(themes are randomly ordered)

Table 3
Emergent themes concentrating on teachers' views of the science teaching in Malaysia

Emergent themes	
Traditional female profession	Teaching has been seen, traditionally, as a female profession.
Didactic approach inappropriate	Teachers believe that student-centred approaches are often more effective for teaching science by helping to create student interest.
Need to enthuse and inspire	Teachers believe that there is a need to enthuse and inspire students in science students in science, creating student interest and involvement.
Teacher-student relationships important	Teachers value the construction of effective teacher-student relationships in helping: effective classroom management, creative teaching, problem solving, assessment.
Time constraints	Requirement for curriculum coverage reduces teachers time to teach creatively and inspire students.
Low student interest in science	Students are cultured in knowledge transfer approach and demand information in an attempt to 'cram' for university entrance exam.
Need to inject fun and relevance into science teaching	Teachers believe that teaching science should involve a fun element and be relevant to students' everyday lives in order to create interest and inspiration.
Need to utilise varied approaches	Teachers believe that utilising varied approaches helps to enthuse and interest students.

(themes are randomly ordered)

Table 4
Emergent themes concentrating on teachers' views of students in Malaysia

Emergent themes	
Lack process skills	Students lack process skills due to knowledge transfer model and poor transition from primary to secondary schooling.
Lack interest in science	Students lack interest in science–few career opportunities in science compared to arts, medicine and law. Also, more interest in 'cramming' knowledge for university entrance exam, no interest in process skills.
Inspiration	Students respond well to science teachers who are enthusiastic about science, inject fun into lessons and emphasise the relevance of science in students' everyday lives.
Student-centred	Students need to discover knowledge for themselves and become actively involved in investigations–aiding better understanding, interest and ownership of learning.
Large class sizes	Inhibit students' learning by reducing opportunities for investigations, discussions and creation of good teacher-student relationships.
Lack of resources	Inhibits students' opportunities to carry out laboratory investigations; obtain accurate information from text books.

(themes are randomly ordered)

The data suggest that participants feel there needs to be a clear strategy for science education in Malaysia rather than adapting fragments of science education models from Europe and the United States (US). The lack of a clear strategy may have contributed to the low prominence which appears to have been given to science resulting in students perceiving science as a lesser career option in comparison to, for example Law. Also, teaching has traditionally been viewed as a female career option with many of the strong male science graduates opting for a career in industry.

Even though the participants believe the Education Ministry operates a top-down system whereby teachers are not consulted for their views on education policy and practice, they do view current Ministry proposals very favourably–the move from a teacher-centred paradigm to a more student-centred paradigm is seen in an extremely positive light. Participants indicated that ATLAS has a key role in this move, providing them with the type of knowledge, understanding and practical ideas they will need to approach their lessons within such a paradigm. However, the participants also indicated that they see a need for utilising a wide repertoire of classroom strategies and approaches, therefore the move from a teacher-centred to a more student-centred paradigm is not a complete shift, but more of an integration process. The participants will continue to use teacher-led approaches when they feel the situation is suitable. Interestingly, the participants' views of students suggest that even though they feel that student-centred approaches help to inspire and enthuse students in science, the students, themselves, may react slowly to the shift in the classroom approach. Their desire to 'cram' knowledge in an attempt to do well in the university entrance exam fits more readily with the more traditional knowledge transfer model of instruction. Even so, the participants are confident that students will, eventually, embrace student-centred approaches in the classroom.

Teaching and learning approaches to science in the primary sector have less of a teacher-centred emphasis and increasingly use more investigative approaches. The participants believe that primary students are developing a panoply of scientific process skills, such as hypothesising and equipment manipulation, as well as developing their interest and enthusiasm for science. Moreover, because the secondary sector is practising within a

heavily-biased teacher-centred paradigm, participants feel that the transition from primary to secondary science lacks continuity. Therefore, students have few opportunities to develop further the basic process skills learned in primary education. In addition to this, investigations in secondary science tend to follow a recipe-based approach that the participants see as having little impact on building student motivation and enthusiasm towards science. However, two factors must be considered here. First, in many schools there is a severe lack of resources–laboratory equipment, access to laboratories and up-to-date text books. Second, class sizes frequently range between forty and fifty students. The participants believe that these two factors significantly reduce teachers' chances of teaching science effectively while building students' motivation, interest and enthusiasm for science.

Effective teacher-student relationships is also an important theme to emerge from the data. The participants feel that the construction of good teacher-student relationships enables good classroom management, creative teaching, teamworking, problem-solving and assessment techniques. Participants suggest that currently teacher-student relationships rarely develop beyond the notion of teacher providing knowledge and student learning. They feel that working with students in a team environment facilitates greater learning potential as students will be more willing to engage the teacher in discussion and question sessions. This is opposed to a knowledge transfer model where the teacher does not usually promote group and whole class discussion.

The data show that participants view ATLAS positively and believe that utilising the approaches can aid development of teachers' classroom practice. Table 5 summarises the key areas which have emerged from the data, and in which ATLAS has the potential to impact effective change in Malaysian classrooms.

Table 5
Emergent themes concentrating on teachers' views of Active Teaching and Learning Strategies

Emergent themes	
Skill development	ATLAS help to develop skills such as: teamworking, communication, artistic, reading, writing, conceptual understanding.
Investigation skills	ATLAS help develop science process skills such as: hypothesising, testing, equipment manipulation.
Inspiring students	ATLAS help to inspire students in science by actively involving students (hands-on).
Knowledge discovery	ATLAS enable students to discover knowledge for themselves–promoting student ownership of learning.
Student-teacher relationships	ATLAS enable closer interaction between teacher and students than knowledge transfer model.
Upper-secondary schooling	ATLAS approaches are less effective at the upper-secondary level–more appropriate for primary, lower secondary level.
Time constrains	Some ATLAS activities are time consuming and need lengthy planning.
Relevance	ATLAS materials need to be adapted to the Malaysian curriculum to be relevant.
Focus	Teachers need careful planning to ensure focus of lesson is not lost in the drive for a creative approach.

(themes are randomly ordered)

The participants view ATLAS as being most effective in enhancing students' skill development, students' inspiration and enthusiasm towards science, students' knowledge discovery, and teacher-student relationship. However, participants feel that ATLAS may be less effective at the upper-secondary level, with students seeing activities, such as games and stimulations, below their academic capabilities. Time constraints are also

considered to be a potential problem by the participants. They suggest that some of the ATLAS activities are very time consuming and may inhibit effective curriculum coverage, while also demanding several hours of teacher preparation and focus.

DISCUSSION

There is little doubt that the participants involved in the ATLAS workshops value the integration of student-centred teaching and learning approaches into Malaysian classrooms. Whether or not integration will be a smooth process is yet to be determined, it is however, likely to be a long and challenging one. A key factor must surely be the extent to which teachers embrace student-centred approaches–an unbridled charge towards change is not advisable. A gradual approach that allows both teachers and students the opportunity to develop their understanding of the mechanism of student-centred approaches is the more tenable option. The process should be one of gradually integrating new approaches which will enable teachers to add to their repertoire of classroom approaches and strategies, rather than rapid major change. Even though the participants feel that teacher-led approaches are quite often inappropriate there are situations when a teacher-led approach is beneficial. Introducing a more balanced repertoire of teaching and learning approaches is required.

There are clear barriers at present that inhibit Malaysian teachers' adoption of ATLAS which need to be addressed. Even though there appears to be a certain amount of cohesion between teachers' thinking and the Education Ministry's current policy, participants involved in this study believe that an even greater process of communication between the Ministry and teachers would be beneficial. Consultation processes which involve representatives from all interested parties, may reduce any perceived communication gaps and establish a forum where ideas and views can be shared and developed to produce a clear and coherent educational strategy that will be embraced by teachers. This process may also involve the promotion of science and science teaching, which is essential in attracting quality graduates into science teaching. The teaching profession needs to receive similar status recognition to that of other professions in an attempt to reduce the drain to subjects such as the arts and law. Finally, issues around poor resources, large class sizes and time constraints, clearly need

to be addressed if teachers are to develop more effective classroom practices.

The partnership between the Centre for Science Education (Sheffield Hallam University), RECSAM, Shell and the British Council is a crucial element in providing support for teachers who intend to develop more effective classroom approaches. Through the ATLAS programme teachers and teacher educators have access to a broad range of approaches which they my adopt and develop while building their confidence and skills. Within ATLAS there are activities and approaches which can readily be applied to curriculum content and are flexible, therefore helping to reduce time constraints imposed by the large amount of curriculum coverage. There are a range of group-based activities and classroom management strategies which can also reduce the difficulties large class sizes pose.

CONCLUSION

The goal of producing a 60 : 40 ratio of science students versus students taking arts-based subjects in Higher Education has not yet been reached within Malaysia's 'Vision 2020'. However, this should act as a spur for developing new strategies in the continuing search for success, rather than acting as a setback to Malaysia's exciting vision for the future.

The integration of ATLAS into the Malaysian teaching philosophy is potentially a way forward. Whether integrating ATLAS with more traditional styles of teaching can have the necessary impact to help overcome the challenges confronting Malaysia's educational system is yet to be determined. However, it is clear that the enthusiasm and motivation that has thus far been generated by the workshop participants, indicates their commitment to student-centred approaches and Malaysia's vision for the future.

There are clearly encouraging signs that ATLAS approaches, linked to the model of training trainers across the teaching training institutions in partnership with the key curriculum and training organizations in Malaysia, is a major step towards a more effective school science programme.

APPENDIX 1

ACTIVE TEACHING AND LEARNING APPROACHES IN SCIENCE

Evaluation Questionnaire

Key: Strongly Agree (SA), Agree (A), Not Sure (NS), Disagree (D), Strongly Disagree (SD).

1. I have gained knowledge and understanding of new teaching and learning approaches.
2. I have gained first hand experience of new teaching and learning approaches.
3. The teaching and learning approaches introduced on the course will help to develop the scientific understanding of students.
4. The teaching and learning approaches can be used with mixed ability students.
5. The teaching and learning approaches can help to motivate and enthuse students in science.
6. The energy materials will be useful to teach the topic of energy in Malaysian schools.
7. The energy topics will help to develop the science process skills of students.
8. The energy materials will help students to understand about energy sources and alternative energy sources.
9. The course has not been very useful.
10. There was a good balance of inputs and activities.
11. I will use some of the new teaching and learning approaches in my teaching.
12. I would like to use the energy materials in my school.
13. I have enjoyed the course.
14. I have not enjoyed the course.
15. The standard of the course was very good.
16. The course has been very useful.