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TEACHING & LEARNING
A Publication for Educators
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USING LANGUAGE LEARNING IDEAS TO LEARN MATHEMATICS

Review by
Ramakrishnan Menon

INTRODUCTION

Many people know of friends who are good at language hut are poor at mathematics. They then conclude that there is a dichotomy hehveen language and mathematics and that learning language and learning mathematics are very different. Admittedly, many differences between language and mathematics, as well as between language learning and mathematics learning, exist. For example, Pimm (1987, p. 207) states that "mathematics is not a natural language in the sense that English and Japanese are," and Ellerton and Clements (1991, p. 125) state that "language teaching methods may not he directly translatable to the teaching of mathematics." However, even they admit that language plays a crucial part in the learning of mathematics. Recently, too, more and more researchers (e.g. Capps and Pickreign, 1993; Greenes, Schulman, & Spungin, 1992; and Menon, 1995) are looking for similarities between language learning and mathematics learning, so as to see how methods used for developing children's language might he used to develop children's mathematics. This paper describes how some language learning ideas might he used to learn mathematics at the Primary school level.

REVIEW OF RESEARCH

Language learning entails listening, reading, speaking and writing. Reading research (Nagy, 1988, cited in Capps & Pickreign, 1993) indicates that students should he exposed to a new word in the four forms (i.e., listening, speaking, writing, reading) several times in the introductory lesson, and subsequently exposed to that word as it occurs in various contexts. Language teachers generally give sufficient time for students to listen, read, speak and write, hut this is not the case for mathematics lessons when students are introduced to mathematics terminology, and are expected to use such terminology immediately. Capps and Pickreign (1993) suggest that mathematics instructional time must include exposure to and reinforcement of new terminology by listening to, as well as speaking, writing, and reading the new words.

According to the mathematics educators Del Campo and Clements (1987), listening and reading are ***receptive*** skills, while speaking and writing are ***expressive*** skills. Receptive skills are more passive, such as identifying given figures as quadrilaterals or triangles, while expressive skills are more active, such as drawing triangles or explaining why the triangle is isosceles. The expressive mode of communication entails the use of one's own constructions, based on personal referents and can either be to explore one's feelings or to explain or both. While both receptive and expressive skills are necessary, Del Campo and Clements state that mathematics teachers overemphasize the receptive mode of communication and neglect the expressive mode of communication in the classroom. Such neglect has to be redressed as their studies show that expressive tasks help children understand and remember mathematics concepts better.

If one compares the teaching of communicative competence in language to that of the increased emphasis on the expressive mode of communication in the mathematics classroom, one can see many similarities. For example, communicative competence is associated with trying to communicate effectively "in context" - i.e. in actual situations—rather than in contrived, repetitive structural patterns of language, say, by using substitutions, as in "The boy is running (walking, crying, talking)." Context has also been shown to be important in mathematics learning (e.g. Capps & Pickreign, 1993), and students have been able to construct and solve meaningful word problems situated in their own experiential context (Menon, 1995).

In language learning, children move from holophrases (e.g. "Mummy candy"-- which might mean "Mummy, give me candy") to more complete, correct utterances through an interlanguage (Corder. 1981). with the help of the child-minder (or significant others), who constantly provides reinforcement as well as the correct language model. So in mathematics learning, Van de Walle (1994) suggests that children should he allowed to use their own words, mathematically imprecise though they may be, before being exposed to, and reinforced with the wrrcct mathematical terminology (for example, the "bonom number" for the "denominator" of a common fraction).

Just as understanding and communication are interlinked in language learning, so, too, should understanding mathematical concepts and procedures be linked to communicating such concepts and procedures through activities ranging from oral explanations and journal writing to written explanations and student-generated word problems. The truism that "to know something really well, one has to teach it to someone else" implies that understanding and communication synergize one another. Hence, "activities that require communication will help students to clarify, refine, and organize their thoughts and to consider alternative approaches and solutions to mathematics problems" (Greenes et al, 1992, p. 78).

IMPLICATIONS FOR LOCAL TEACHERS

It is true that mathematics teachers in Singapore are under pressure to cover the syllabus and ensure students do well in public examinations. But it is also true that, after covering the syllabus and giving (and marking) umpteen exercises and worksheets, a sizeable number of students--as evidenced by remedial and private tuition classes--still have difficulties in mathematics. One possible reason for this state of affairs is premature symbolism and excessive mechanical practice without paying attention to possible language factors affecting mathematics learning. This is where a look at how links between language learning and mathematics learning might actually be implemented in the mathematics classroom would prove fruitful. Listed below are a few suggestions on how to translate language learning ideas to enhance mathematics learning.

1. Introduce, discuss and reinforce new terminology

In language learning, new words are related to previously-learned words and confusion arising out of similar-sounding words and of different contexts are discussed so as to clarify the meaning of words. Hence, to learn mathematics effectively, mathematics learning should connect everyday language with mathematics language, as well as with context and multiple meanings (Capps and Pickreign, 1993).

In practice, this means that when a new word is introduced, write it on the board. Spell it, pronounce it and let students listen and repeat after the teacher. Relate it to a previously-learned, similar word, and discuss similarities and differences between the new and "old" word, as well as discussing its meaning and derivation. Give exercises such as discriminating between similar words, and matching words/phrases (e.g. synonyms, opposites).

<u>Examples</u>

a) ***Perimeter: "peri," meaning "around." and "meter," meaning "to measure." So, "perimeter' means "measuring around."***

b) ***Match words that are similar***

is a factor of	***minus***
add	***can divide***
substract	***plus***

c) *Does a "right" angle mean there is also a 'wrong" or "left" angle?*

2. **Meaning,** pronunciation and context

Discuss how the meaning/pronunciation of mathematical symbols and terms differ accroding to different contexts.

Examples

a) *The "square" as a shape compared to the Square' of a number and the everyday use of the word as in a 'square' meal.*

b) *The number **2**, pronounced "two" compared to the homonyms "to" and "too."*

c) *"Degree" as in angle measure compared to temperature, a university degree, or as in "a matter of degree.'*

d) *In the number **235.** the **3** is **3** tens, or "thirty," but the answer to "How many tens in 235?" is "**23** tens' nor "thirthy" or "**3** tens." However, the answer to "What is the value of the 3 in 235?" is "**3** tens" or "thirty."*

3. Encourage student-generated questions or word problems and discussion

Because student experience and context are so important for student understanding and successful solution of problems, one could begin by a meaningful word problem situated in the student's experiential context (e.g. "If there are 17 girls in this class of 32, how many are boys?") and ask for students' solutions, followed by a discussion of the various solutions, even before teaching the algorithm. This contrasts with the usual practice of starting of, say, with the symbols 32 - 17 (without putting the symbols in the context of student experience), and explaining the subtraction algorithm involving renaming, followed by repetitive, mechanical practice, using other two-digit numbers.

Such an approach is similar to the process approach in the leaning of language. For instance, in process writing, children are encouraged to have ownership of their writing by writing about things close to their experiences, without worrying too much about the grammar or spelling, as well as have 'conferences, drafts, and redrafts." So, in mathematics students could write their own word problems, based on their own experiences such as shopping, and refine their questions and solutions through "discussion, explanation and justification."

Examples

a) *Given the numbers **25** and **5**, prepare a one-step word problem involving addition and solve it. Show how you worked out the answer. Exchange your wordproblem (without the answer, or your working) with that of your neighbour and work out each other's problem. Be prepared to explain to the class how you worked out the problem(s).*

b) *Use the same numbers (25 and 5) and change the word problem into a two-step wordproblem by just changing a few words in your one-step word problem.*

c) *Use the same numbers (25 and 5). prepare a one-step wordproblem involving subtraction (or multiplication or division) and solve it.*

d) *Prepare a question (numerical or word problem) where the answer is 5.*

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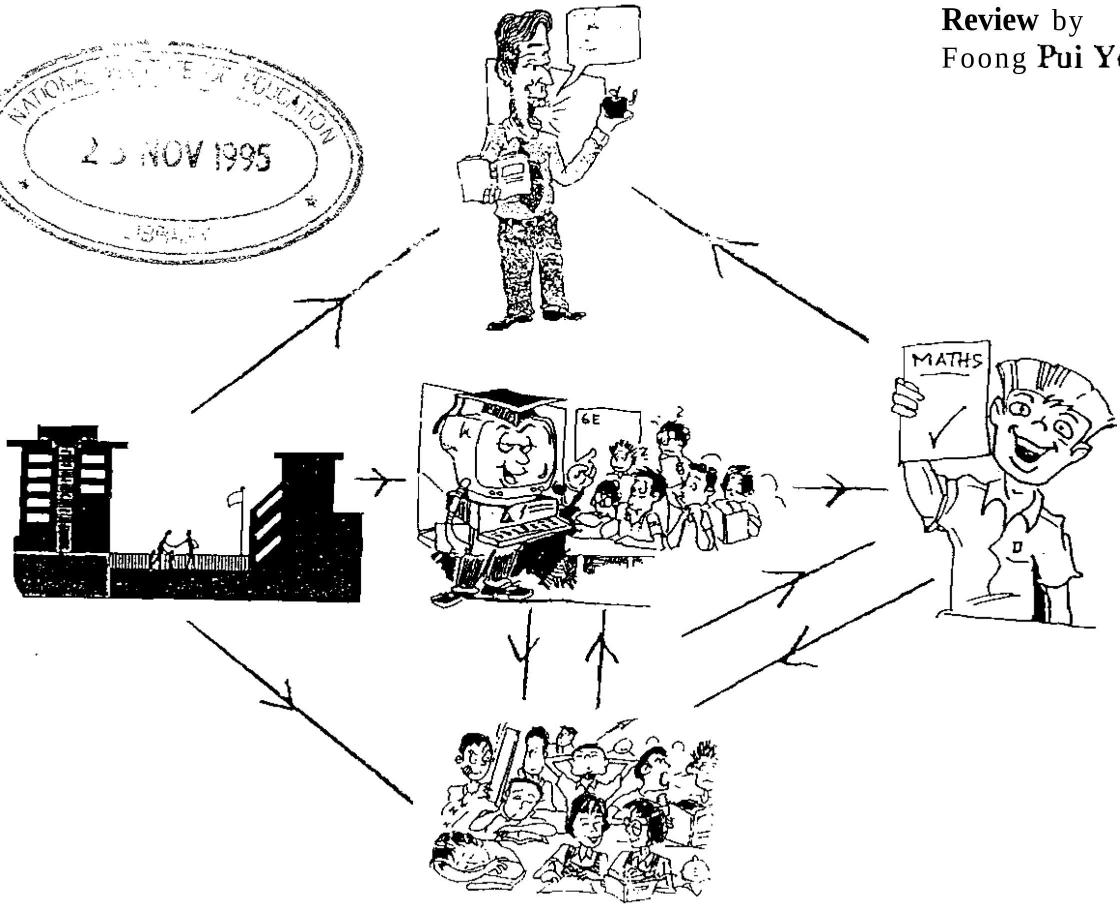
DISPARITY IN MATHEMATICS ACHIEVEMENT
A MODEL TO EXPLAIN RACE, SEX AND SES DIFFERENCES

Review by
Foong Pui Yee



INTRODUCTION

Knowledge of mathematics is essential for all members of our society for educational advancement and unrestricted choice in job opportunities. Singapore prides herself as a meritocratic society where equal opportunities are provided in school for every child regardless of race, sex or social creed. Unfortunately like in other countries, certain groups are achieving significantly below their peers on a national level. Figures from the Ministry of Education (Straits Times, Nov 1990) which traced the performance of different ethnic groups in major examinations over the years (1973 - 1983), showed that Malay and Indian students fell rapidly behind the Chinese in mathematics as they moved up the education ladder. Although in more recent years, there has been a general increase and narrowing of gap in achievement between groups, the Malay students achievement in mathematics still lagged behind the other races (Straits Times, May 1994). Within group there are reasons to believe that children from low socioeconomic status (SES) background do not achieve up to their potential (Anick, Carpenter & Smith, 1981,). Disparities in mathematics achievement can be found in most School systems around the world that have diverse student populations (Secada, 1992). However educators agree that schools cannot be held totally responsible for differences in achievement patterns Of different population groups, more research must be done to identify the many other factors within a social structure that can affect students' performance in school.

A MODEL TO EXPLAIN DISPARITY IN MATHEMATICS ACHIEVEMENT

Achievement in mathematics is often used as an indicator of "how much" mathematics someone knows or possesses-and hence scores on standardised achievement tests have been a primary source of evidence for investigating inequality in the education of diverse groups. Achievement in mathematics can be differentiated by content area and cognitive level. In their study (Anick, et al, 1981), found that the averages of 17-year-old blacks and Hispanics were consistently below the national average in the knowledge, understanding, skills and applications of mathematical concepts. There was some evidence that topics like measurement, geometry, graph and statistics were disproportionately difficult for black students although they were reasonably good at computation as compared to the national population. In Singapore, the Malay primary pupils had more difficulties in solving number problems than the Chinese pupils (Lam, Azar & Foong, 1994). Cited in Reyes and Stanic (1988), 8-year old students of differing SES levels excelled at different types of problem solving tasks. The low-SES cbildrenperformed better than the high-SES children on some of the tasks that required creativity; and the high-SES children performed better on other tasks, usually those most similar to school activities. At the high school level, Fennema (1990) found that male students, as a group, achieve at a higher level in mathematics than female students; and the difference is largest for application and problem-solving tasks.

Reyes and Stanic (1988) believe that differential performance in mathematics can be fully understood if the factors of race, sex and SES are studied not in isolation from each other but also in relation to other underlying factors. They propose a Model, see figure A, that identifies five causal factors for the student achievement differences based on race, sex and SES. The five factors are societal influences, teacher attitudes, classroom processes, school mathematics curricula, and student attitudes and achievement-related behaviour. In the Model a single arrow represents a one-way causal connection; a double arrow represents reciprocal causation. For example, student achievement is directly affected by classroom processes, student attitudes, and student achievement-related behaviour. Student achievement also has a direct effect on teacher attitudes which in turn has a reciprocal effect on the mathematical curricula.

SOCIETAL INFLUENCES

Societal influences outside of school may send different messages to and about students of different race, sex and SES regarding their aptitudes and the appropriateness of their achieving at a high level in mathematics. Example of societal influences are the family, the community in which the child lives, the mass media and other societal roles held by members of particular groups. In Singapore there used to be a mythical notion that the Chinese community is concentrated in trade and commerce because they are "good at calculations". Clements and De Campo (1990) provide evidence that children in different cultures have different ways of thinking about numbers and numerical relationships. Aboriginal Australian children consistently scored lower than White Australian children in mathematics tasks phrased in the western language. In Singapore mathematics is taught in the English language which is not the mother tongue of Chinese, Malay and Indian students. There seems to be some relationship between degree of proficiency in a given language and mathematics achievement in that language (Secada, 1992). Figures have shown the children who use more English at home, usually from high or middle SES, have an advantage in mathematics achievement over the others who used more of their mother tongue at home. It was reported that there were high levels of home support for mathematics for both sexes in countries with low levels of gender differences in mathematics performance whereas there tended to be low levels of parental support for mathematics in countries with substantial differences in achievement. Reyes and Stanic (1988) state that there is little research done on the effect of societal influences on the other factors in the model because documenting these connections is difficult although it is a very necessary direction for future research on differential achievement in mathematics.

TEACHER ATTITUDES

It is thought that teachers tend to develop unsupported preconceptions of their students' abilities based on race, ethnicity, SES, gender or some other demographic characteristic. Their expectations are then communicated to students who live up (or down) to them. As a result teachers tend to structure life in the classroom where student opportunities and participation are constrained based on those preconceptions. Subsequently, student achievement rises or falls contingent on those initial beliefs. Brophy (1985) found that teachers do establish differential patterns of interactions with their students that vary based on student dzmographic characteristics. Male students tended to receive more criticism, be praised more frequently for correct answers, have their work monitored more frequently and have more contacts with their teachers than the female students. Teacher expectations and teacher attitudes have been found to affect student achievement. In the Model classroom processes serve as the mechanism through which teacher attitudes affect student achievement.

CLASSROOM PROCESSES

Studies on sex-related and race-related differences in classroom processes (Matthews, 1984) have shown that certain patterns of classroom interaction affect student achievement in mathematics. Although many studies have found that increased lecture demonstration time and a high rate of questioning were correlated to enhance achievement, such classroom process may be differentially effective for different student backgrounds. For instance, students from low-SES backgrounds and African American and Hispanic students who are low-achieving are said to resist participating in classroom processes (Grant, 1989); they may not answer questions for example. In another study it was reported that cooperative learning appears to improve student achievement among American Indian students as they traditionally come from extended families and tend to be group oriented. They tend not to respond to competitive learning situations. Due to teachers' perceptions of their abilities, lower ability stream students were generally not exposed to more challenging mathematical problems but instead given large doses of drill and practice on basic skills. Stanic and Reyes (1988) recommend that more qualitative work is necessary to develop instruments that describe the richness of classroom processes that contribute to mathematics achievement differences by race, sex and SES.

SCHOOL MATHEMATICS CURRICULA

School mathematics curricula consist of the courses available to students, the topics covered in those courses, and the activities used to teach those topics. In the Model the school mathematics curricula has a mutual effect on teacher attitudes which in turn affect student attitudes and thence achievement. Teacher attitudes may affect school mathematics curricula in that teachers may decide that certain courses, topics and activities are appropriate only for certain groups of students. Anick et al (1981) found that participation in advanced mathematics courses is an area where serious inequities exist for black students which may help to explain why the difference between achievement of blacks and the national averages increases with age. This confirms Matthews (1984) finding of a situation arising from the attitudes held by teachers that as the proportion of black students in the school population increases, the likelihood of the mathematics curriculum containing lower level course increases. Lower ability stream students were generally not exposed to more challenging mathematical problems but instead given large doses of drill and practice on basic skills.

STUDENT ATTITUDES AND ACHIEVEMENT-RELATED BEHAVIOUR

Examples of student attitudes are confidence in learning mathematics, perceived usefulness of mathematics, beliefs about themselves as learners of mathematics and the attributions of success and failure in mathematics. Some examples of achievement-related behaviour are math anxiety, motivation, persistence, independence, self-concept and self-expectation; attitudes toward other students and toward teachers. A comparison of mathematics anxiety levels between Malay and Chinese female students in Singapore (Foong, 1984) showed that the Malay female students were more anxious about mathematics than their Chinese counterparts. These affective variables are often used as predictors of achievement in mathematics. In the Model, student attitudes and achievement-related behaviour are affected by the school mathematics curricula and societal influences and they have reciprocal effects on classroom processes and student achievement. According to Matthews (1984), confidence appears not to be as important in understanding race-related differences as it is in understanding sex-related differences. Black students' feelmg about mathematics and themselves as learners of mathematics compared favourably with those of their peers. Black students not only responded that they liked mathematics and thought it was important, they also indicated that they wanted to do well in mathematics and were willing to work hard to do so. Fennema (1990) suggested that sex differences in stereotyping of mathematics as a male domain may be an important factor in the differential achievement of male and female students. There may be race and SES differences in perception of mathematics as a white domain but this claim has not be documented (Matthews, 1984).

IMPLICATIONS FOR FUTURE RESEARCH

Singapore is a multi-racial society of 2.7 million people, with about 78% Chinese, 14% Malays, 7% Indians and 1% belonging to other ethnic groups such as Eurasians, Jews and Arabs. The Singapore government sees education serving one of it main purposes as a means of developing human capital to maintain Singapore's international competitiveness as an industrialised country. The education system has been improved to emphasise English, as a working language, and Mathematics. The underachievement of Malay pupils in mathematics has always been a concern among many parents and community leaders as well as national leaders.

The Model proposed here by Reyes and Stanic can be used as a useful guide for further conceptual work and research. Although the review of literature on the five causal factors cannot be extensive in this article it gives a better understanding of the complexities involved. Research involving mathematics achievement and other disparities among groups should be multi-dimensional in scope. For future research it will be helpful to explore the interaction of race, sex and SES for the causes to which they attribute to mathematics performance, attitude and classroom participation. Student learning as measured by student achievement is at all times the dependent variable and attention must be directed to the effects on student achievement associated with the five factors discussed in this review.

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DIFFICULTIES FACED BY STUDENTS IN LEARNING CHEMISTRY

Review by
Boo Hong Kwen

INTRODUCTION

Many students, including those who are specialising in science at A-level, find the learning of science subject material to be difficult; this appears to be especially so in the area of Chemistry. Few students appear able to adopt a scientist's approach of seeking generality of theories to explain a wide spectrum of events thus leading to predictive/deductive capability. Instead, they tend to see science as a mass of unrelated formulae and equations, each to be applied to a specific and well bounded problem area. With such a bewildering mass of formulae and no apparent logic of prediction, it is hardly surprising that to many students, chemistry is little more than modem day alchemy.

This article reviews a number of works which address this issue either directly or indirectly as a result of studying pupils' understandings and conceptions in science. It also suggests some guidelines that teachers should consider in their own approach to presenting science in the classroom.

RESEARCH REVIEW

Some possible reasons for the difficulties faced by students include the following:

(i) Difficulties with microscopic **concepts:**

A recent detailed study of A-level student's conceptualisations in chemistry (Boo, 1994) highlighted the difficulties that many chemistry students experience in crossing the boundary between the macroscopic and microscopic views of chemical phenomena. Almost everything within chemistry is based on an understanding of the microscopic world - the world of particles (ie atoms, molecules and ions), and their interaction, which cannot be experienced or felt or easily deduced from macroscopic phenomenon. This is in contrast to subjects like physics and biology where many of the topics are based on the macroscopic world and can be experienced or deduced from experience. The conceptual inexperienceable aspects of chemistry are especially difficult to learn; especially so in the face of competition from perceptual thinking which is so much a part of everyday experience.

Schollum and Osborne (1985) similarly reported that "the theoretical aspects of chemistry which the teacher introduces can produce immediate problems. The world of atoms, particles and molecules does not fit in with the world as they (ie the pupils) already know it."

The conceptual leap from the macroscopic to the microscopic is further hindered by confusion in the use of words or terms which often have a specific meaning in chemistry but may have a variety of meanings in other scientific disciplines, learning domains or everyday life (examples of such terms are "reaction", "burning", "spontaneous"); a point highlighted in the next category of difficulties faced by students.

Thus it was found that students (even at A-level) tended to use perceptual thinking instead of conceptual thinking in their deliberation of the various aspects of a number of demonstrated chemical reactions. For example, in discussing the burning candle, many A-level Chemistry students viewed the candle wax as not involved in burning (and hence not involved in any chemical change), based on their observation that it was merely melting and not being "set alight" (unlike the case of the candle wick, which was perceived to be "set alight" and hence, burning.)

ii) Inconsistencies within chemistry and between science subjects

A number of researchers (Fensham and Kass, 1988; Carr et al, 1987) have suggested that one of the reasons why students find science in general, and chemistry in particular, so difficult is the multitude of ways in which terms and definitions are used both within subject domains and across the sciences. For example, Fensham and Kass highlighted common inconsistencies in the writing of chemical formulae between inorganic and organic chemistry. Other difficulties observed by Boo (1994) and associated with inconsistencies within chemistry were seen in some students' confusion concerning the meanings of oxidation reactions, where it seemed that meanings of oxidation in organic chemistry had not been reconciled with meanings and definitions in physical and/or inorganic chemistry.

Difficulties associated with inconsistencies between science subjects are highlighted in considering the topic of energy. Carr et al (1987) pointed out that many students had difficulty in reconciling the concept of chemical energy with energy as studied in Physics. Boo (1994) observed that many students appeared to transfer the idea from physics that energy is required to make things (ie 'energy is the capacity to do work') and therefore formulated the concept that energy is required to make bonds. This appeared to be further supported from biology lessons where they perceived energy that is stored as food in plants (or in "energy-rich" substances) as being analogous to the storage of energy in chemical bonds. Faulty transference of ideas such as these to chemistry resulted in deeply entrenched misconceptions associated with bond making and bond breaking (eg that bond making requires input of energy; and bond breaking releases energy).

iii) Discrepancies between school science and actual science

As suggested by Reif and Larkin (1991), students' lack of awareness of the differences between everyday life and science in terms of the goals and the cognitive means used for goal anainment can lead to widespread difficulties in learning science. They analysed these difficulties in terms of students' erroneous conceptions of the goals of science, and their transfer of goals and ways of thinking which are effective in the everyday life to the domain of science. For example, in everyday life goals ruughly relate to having a satisfactory life and various kinds of knowledge can be used as appropriate in different contexts without requiring great generality. In contrast the central goal of science is to achieve optimal prediction and explanation by devising theoretical constructs which parsimoniously permit inferences about the largest possible numher of observable phenomena.

Some specific discrepancies identified by Reif and Larkin were:

* Many students do not share the scientist's focus on making inferences and transcending existing knowledge (ie of constructing concepts, generalisations, underlying principles or models based on observed facts or existing knowledge). lnstead these students view scientific knowledge predominantly as a valuable collection of facts and formulae rather than as a conceptual structure enabling numerous predictions.

* Many students do not aim at the scientific goal of understanding as demonstrated by the ability to make extensive inferences. As a result, they often acquire scientific knowledge which is inert rather than flexibly usable.

* Under the pressures imposed by public examinations, these problems are exaggerated hy many students believing (with some justification) that they can cope better by memorising standard results than by engaging in the longer reasoning processes needed for systematic problem solving.

iv) Discontinuity between chemistry learned at lower levels and at A-level

Besides the various sources of difficulties discussed above, another source of students' difficulties in learning A-level chemistry, according to Boo (1994), comes from the discontinuity in students' learning experience between lower level chemistry, including GCSE, and A-level. From the students' perspectives, much of what they learned at the lower levels seemed inconsistent to what they were learning at A-level. For example, at the lower levels they learned that magnesium displaces hydrogen in the reaction between magnesium and dilute hydrochloric acid to form magnesium chloride which suggested that a bond is formed between Mg and Cl. At A-level, they learned that in fact chloride ions are not involved at all in the chemical reaction; instead, they are mere spectator ions.

IMPLICATIONS FOR THE SCIENCE CLASSROOM

A key problem underlying many of the issues reported above is that many students perceive science to be an exact and immutable set of rules rather than recognising that scientific knowledge is never absolute. Instead, scientific knowledge is tentative, and subject to constant revision; and that current scientific models and theories are but the best theoretical models that we currently have, both to explain observable phenomena and to serve as a basis for predicting the outcome of postulated events. As such, scientific models and theories are being constantly refined in the light of new discoveries. One only has to think of our changing view of the composition of matter from the four elements (earth, air, fire, water) of Aristotle's philosophy though Dalton's atomic model to our current understanding of the elementary Particles.

Despite the fact that we live in a 'scientific' age, few students ever get to know or talk with a Practising scientist. As Schollum and Osborne (1985) point out: "To most children the science teacher is the only 'scientist' they know - certainly, the only 'scientist' who knows them". Thus, the science teacher represents, in most cases, the only contact with real science that students encounter and therefore it is only the science teacher who is in a position to shape the students' views on both the roles and objectives of science and on their realisation in specific subject domains.

In order to aid chemistry teachers (and science teachers in general) the following suggestions are offered:

1. Encourage students from their first introduction to science not to see science as a mere accumulation of facts and formulae but as a way of thinking to enable them to make sense of the real world around them.

2. Help students to differentiate between science goals and scientific ways of reasoning and everyday goals and ways of thinking.

3. Ensure that students recognise that scientific theories are models of our current understanding and not an immutable set of facts and rules. Implicit in this is that students should be encouraged to challenge their own scientific models where these models do not adequately explain observable phenomena, thus leading to model expansion and refinement in the learning process.

4. The concept of the model - "the way we scientists visualise it" - represents a good way of introducing the sometimes difficult concepts of the microscopic world which are so important in the understanding of chemistry.

5. Similarly, the apparent discontinuities between 0-level and A-level chemistry can be presented in terms of refinement and expansion of the model.

6. Always seek feedback from students on their understanding of new terms and concepts as they are introduced, particularly where terms (such as energy, burning, reaction) are used in other scientific disciplines or have meanings in everyday life which could be confusing when considering their specific application in science.

7. Encourage students from the earliest age to develop their reasoning and deductive skills rather than simply their ability to memorise and order facts and formulae.

8. Try to make science both enjoyable and relevant to everyday life.

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IMPROVING EXPLANATION SKILLS FOR ENHANCING UNDERSTANDING IN SCIENCE

Review by
Lucille Lee Kam Wah

INTRODUCTION

Students sometimes complain about being unable to understand science even though it appears o be an interesting subject to many of them. Science is a subject to be taught preferably by an inquiry ipproach through the use of many hands-on activities and teaching materials. With this teaching ietting and the first-hand learning experience offered to our students, why do students still have lifficulty in understanding certain concepts? Besides using the teaching ideas and materials already ivailable (e.g. CDIS packages), what can a teacher do to further facilitate student learning of science? This article reports on some research findings concerning factors influencing effectiveness of science nstruction and the importance of explanation skills in effective instruction. Some suggestions for mproving explanation skills to enhance students' understanding are discussed.

FACTORS INFLUENCING EFFECTIVENESS OF SCIENCE INSTRUCTION

There are numerous studies researching teacher effectiveness and clarity. One such recent itudy (Killen, 1994) investigated the factors influencing students' understanding of science lessons. The study involved 955 junior high school students from four countries, Australia, USA, Finland and he Republic of South Africa, in an attempt to identify aspects of teacher effectiveness that were common and unique to the four countries. The age of the students ranged from 13 years to 16 years. The students were asked two open-ended questions at the end of regular lessons in general science, physics, chemistry, biology or mathematics by their own teachers. The two questions were: "In this lesson what things did the teacher do to make it easy for you to understand the lesson?" and 'In this lesson what things did the teacher do that confused you or made it difficult for you to understand the lesson?"

The students in the study identified 43 distinct teacher behaviours that helped them to understand the information presented by their teachers. These behaviours, namely, facilitating teacher behaviours, were further grouped into six broad categories: teacher explanations, demonstration/use of teaching aids, students activities, teachers interaction with students, teacher help for individual students and teacher communications style. The common facilitating teacher behaviours identified by students from these countries are listed below:

Teacher <u>explanations</u>
- *Were derailed*
- *Well sequencedlstep by step-by-step*
- *Clear and simple*
- *Were repeated*
- *Incorporated everyday examples*

<u>Demonstrations/use of teaching aids</u>
- *Diagrams/charts were used*
- *Transparencies were used*
- *Demonstrations were included*
- *Things were written on the board*

<u>Student activities</u>
- *Activities/worksheets/homework were given*
- *Notes were taken*

Teacher interacrion with students

- *Students were asked quesrions*
- *Students comprehension checked*

Teacher help for individual students

- *Things were re-explained when students didn't understand*
- *Individual help was given to students*

Teacher communications style

- *Humour injected into lesson*
- *Words were clearly and loudly spoken*

The teacher behaviours that confused the students or made it difficult for them to understand the information presented were called limiting teacher behaviours in the study. Twenty-nine limiting teacher behaviours were identified and they were classified into five broad categories: teacher explanations, lesson structure, pace of the lesson, teacher questioning, and teacher communications style. The common limiting teacher behaviours identified by the students are listed below:

Teacher explanations

- *Used words that students did not understand*
- *Things were not explained in detail*
- *Explanations were not clear*
- *Too much content was included in the lesson*

Lesson structure

- *The subject was changed from one thing to another*

Pace of the lesson

- *Words were spoken too quickly*

Teacher communications style

- *Too much talking was involved*

The results of the study indicated that about half of the students considered their teachers' explanations as one important factor that helped them understand the lessons. This is not surprising since a large part of science teaching is concerned with explanations. Explanation serves a significant instrumental purpose within science for making the content knowledge comprehensible.

SOME SUGGESTIONS FOR IMPROVING EXPLANATION SKILLS

It is clear from the above review that explanation is very important for helping students to understand science concepts and the links between the concepts and the phenomena observed. Very often, teachers do not explain adequately or in detail (Dagher and Cossman, 1992). As a result, student learning of content knowledge is acquired by rote learning rather than conceptual understanding. A few suggestions are raised now for the improvement of explanation skills.

1. Make explanations clear and systematic

To explain a concept or phenomenon, teachers must decide precisely what they want u, explain, e.g. three states of matter. They set the key points by identifying the key words related to the topic concerned. These key points can be transformed into questions to raise students attention, e.g. what is matter? Each key point is then explained with appropriate examples or everyday examples. Students' comprehension should be regularly checked. Repeat the explanation if students still do not understand. Attempts should be made to conceptually link all the key points to allow students to fully understand the whole explanation. Teachers should avoid using difficult words or talking too much about irrelevant matters (Killen, 1994).

2. Use different types of explanations

A teacher's understanding of the nature or types of explanations can promote the use of more clear explanations and, subsequently, serve to facilitate student learning. The types of explanations by science teachers have been studied and reported. Dagher and Cossman (1992) investigated the nature of explanations used by science teachers in junior high school classrooms. Ten types of explanations, namely, analogical, anthropomorphic, functional, genetic, mechanical, metaphysical, practical, rational, tautological, and teleological, were identified based on observations of 40 class periods of science instructions during which the classroom discourse was audio taped and later transcribed. *Genetic, mechanical, practical, and analogical* explanations occurred most frequently in this study. A *genetic* type of explanation relates an antecedent sequence of events. Talk about what happens but not why. A *mechanical* type explains causal relationshipsusing scientific law. A *practical* type involves instructions as to how to perform the practical. An *analogical* type involves using analogy in explanation. The results indicated that teacher explanations did not vary considerably. The former three types of explanations, genetic, mechanical and practical are quite similar to the three types of explanations described by MacDonald (1991) as interpretive, reason-giving and descriptive. The *interpretive* explanation answers 'what' questions and establishes the meaning and the boundaries of a concept. Reason-giving explanations answer 'why' questions. A *descriptive* explanation answers 'how' questions and illustrates a procedure or series of steps or events that occur when achieving a final goal.

3. Use analogies

Treagust (1993) suggests that the use of analogies can effectively communicate concepts to students of particular backgrounds and prerequisite knowledge. The familiar world concept is usually used as the analogy to assist in the explanation of the scientific concepts. Analogies can help student learning by providing visualization of abstract concepts, and by comparing similarities of the students' real world with the new concepts. For example, students walk around the classroom in such a manner that their direction of travel is analogous to the motion of electrons through a solution during electrolysis. However, there are some constraints of analogies. Inappropriate use of analogies can lead to incorrect or impaired learning. For example, the analogy used in the explanation may be unfamiliar to the students, or the students may lack visual imagery or analogical reasoning, then the use of analogies may be limited. Treagust (1993) suggests that teachers should reflect on the clarity and usefulness of the analogy and consider ways in which the analogy may he improved.

4. Use an interactive approach

Appleton (1993) investigated the effect of the Interactive Approach described by Biddulph and Osborne (1984) on student hehaviours in science lessons. The study examined Grade 7 (equivalent to Secondary one) students' responses in the two science lessons that were designed to encourage students to ask questions then propose and test their own hypotheses. The teaching involved a demonstration designed to present a discrepant event or puzzling situation. The demonstration was conducted with little explanation or comment. The students were then invited to ask questions about the demonstration and materials. The teacher answered questions with either a 'yes' or 'no' or repeated the demonstration to provide an answer. Students were free to discuss ideas amongst themselves whenever they wished. Each of these lessons was intended to serve as an introduction to the topic and were followed by subsequent lessons.

CONCLUSION

An important contribution to the effective instruction of science lessons can be made by teachers' understanding of content knowledge and knowing how to transform it into knowledge for teaching. It is evident that clear explanation is essential for students' understanding of science concepts. For developing more effective explanation skills, the teacher can stress the key points and try to use different types of explanations such as 'interpretive', 'descriptive', or 'reason-giving', to make the lessons more interesting and stimulating. Appropriate analogies can be frequently used for explaining abstract or difficult concepts. The teacher needs to constantly check on the effectiveness of analogies used and avoid creating confusion or introducing misconceptions. The teacher can use the interactive approach with or without discrepant events to make the teacher-students interaction more dynamic and hence promote student active learning. Explanations can be introduced after the students' ideas are elicited as this is the time when the students are more prepared for learning.

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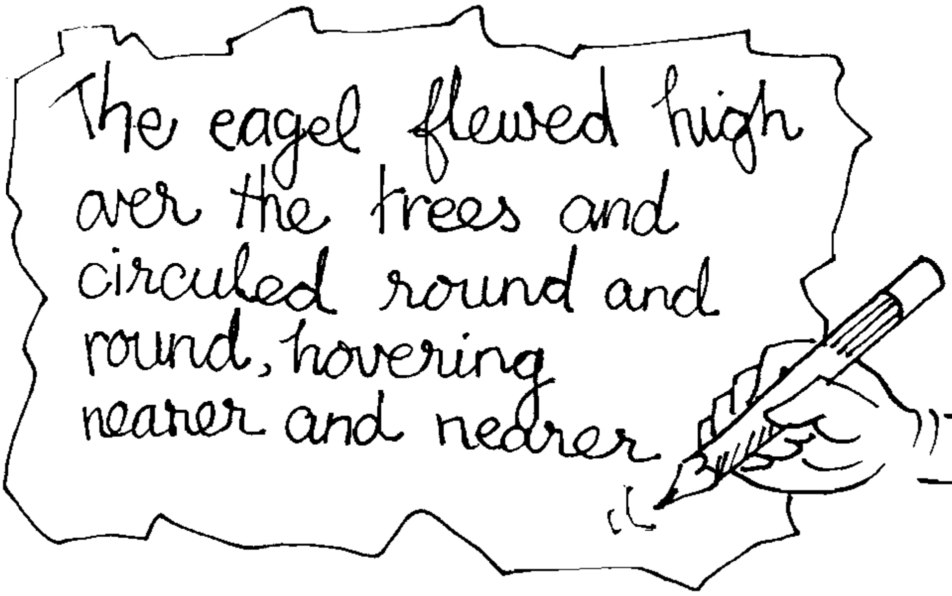
HOW SHOULD TEACHERS RESPOND TO STUDENTS' WRITING?



Review by
Tan Poh Ching

INTRODUCTION

For the past decade, research in education has shown that a paradigm on responding to student writing is gradually emerging. The emergence of this paradigm has been highlighted in articles and journals like College English and in the latest published books. Such a paradigm introduces new styles of commenting on student's writing for teachers. (C. W. Griffin, 1982)

However, it is discouraging that, despite the emergence of the above paradigm, no radical changes have been made to the ways that teachers (from upper primary level onwards) comment on students' writing in Singapore. Presently, teachers still comment on writing in the traditional manner (the emphasis is on the product rather than on the process) even though "process writing" has been briefly highlighted by the Ministry Of Education. Teachers do not always respond to students' writing by giving thoughtful comments that will help students to evaluate their purposes in writing a specific text. As a result, many students still write poorly even though they have spent many years in primary school writing essays!

Therefore, it is important for teachers to understand the nature of commenting. They should comment with the greatest emphasis on the <u>process</u> of writing instead of on the <u>product</u> of writing. They should also differentiate meaningful comments from confusing ones. These two areas of commentary are crucial and should not be overlooked.

In this review of keynote papers on the new paradigm, research showing the defects of the present style of commenting will be discussed first. New forms of teacher commentary as suggested by the emerging paradigm will then be followed.

PROBLEMS IN THE PRESENT STYLE OF COMMENTING

Presently, teachers seem to have inadequate information with regard to process writing. As a result, they sometimes make comments in essays that may be inappropriate for process writing. Two major problems will be discussed in this section.

PROBLEM 1:

At present, teachers tend to take students' attention away from their own purpose in writing a particular text and focus their attention instead on the teachers' purpose in commenting. (Sommers, 1982) This problem happens particularly when teachers carry out tasks like identifying mechanical errors, giving contradictory messages and not ranking the importance of their comments in the students' first draft. There are three types of problems in this area:

(a) Identification of mechanical errors

According to Dennis Searle and David Dillon (1980), upper primary school teachers tend to comment more on form (word choice, spelling and paragraphing) rather than on content when responding to students' first draft of writing. These teachers have a special purpose, that is, to search for mechanical errors when commenting the first drat?. This action in the present style of commenting is termed by Joseph M. Williams (1981) as a conscious act. Such actions from teachers lead them to perceive errors as something that need to be eliminated as soon as possible. They do not view errors as powerful diagnostic tools as perceived by Barry M. Kroll and John C. Schafer (1978). As a result, students are thus usually asked to correct these mechanical errors when they revise.

Due to the above, students have a wrong impression of the importance of errors. Teachers' comments lead students to believe that mechanical errors are important at this stage and thus should be attended to before the meaning of the text. Some are even led to believe that the meanings of their text is already there. They only need to correct these mechanical errors to achieve an excellent piece of writing. Obviously, such comments discourage students from seeing their writing as a whole discourse.

(b) Giving contradictory messages

Often, students are given contradictory messages. For instance, students are first asked to condense a sentence to make it more precise and then told to develop more of a particular paragraph to make it more interesting to a reader. The first task encourages the students to see the text as a fixed piece that just needs some editing while the second task suggests that the meaning of the text is not fixed. These two separate yet conflicting tasks cause confusion to the students. As a result, students are not able to carry out revision successfully.

(c) No ranking of comments

Comments that are given by teachers presently are not usually ranked according to the order of importance. These comments are worded so that it is difficult for students to differentiate the most important problem in the text from the least important one. For instance, students who are required to reorganise the ideas of a text and correct punctuation simultaneously may view the latter as the more important task. The lack of an appropriate scale to show the ranking of comments and the language used in the present style of commenting thus create an ambiguous situation for editing.

PROBLEM 2:

Most comments that are given by teachers are not text-specific. These comments could be rubber-stamped from text to text. They thus would make as much or as little sense of the second text as the first one. Asking students to think about the audience is an example of an abstract comment. These abstract comments cause students to perceive revising as a guessing game. They suggest to students that writing is just a matter of following rules. No strategies for carrying out these comments are offered.

HOW COULD TEACHERS COMMENT EFFECTIVELY AND MEANINGFULLY?

Due to the above mentioned problems with the present method of commenting, some new effective ways of commenting have to be introduced. The new emerging paradigm on responding to students' writing provides ideas on how teachers can comment effectively and meaningfully in student essays.

(a) Focus on content instead of form (technical parts)

For effective and meaningful commenting to occur, teachers should focus more on the content (the development of and logical consistency between ideas) rather than on the form (technical portion) in the first round of revision. The goal in this revision is to engage students with the issues concerned to clarify their purposes in writing. This is not a completed piece of work (the first stage in the whole process of writing). Thus, teachers should try to ignore minor mechanical errors that appear in the writing. Most importantly, focusing on content will enable teachers to comment in such a way that show they are marking a process of writing and not on its final product.

(b) Use errors as diagnostic tools

As this is process writing, teachers should not search consciously for mechanical errors when marking the first draft. By searching consciously for errors, they have changed their initial purpose of guiding students through a complex process of writing into the purpose of grading a piece of writing. Instead, they should read the whole piece of writing for its own value.

However, if errors do occur in the first draft, teachers should view such errors as powerful indicators of the kinds of problems students have and note down their strategies for solving them. Teachers should not perceive errors as "diseases" which are to be eliminated as soon as possible.

In order to investigate the pattern of errors in a student's piece of writing, two techniques can be used. Teachers could either interview the student and ask him/her to explain the error or ask the student to read the piece of writing aloud and orally reconstruct the text. (Bartholomae, 1980)

(c) Focus on writing mth audience consideration

Audience consideration is another important aspect to be considered in process writing. As students need people to listen to and respond to their ideas in order to find out whether they have conveyed their intended messages, teachers should comment in such a way so as to imply the presence of a reader. Teachers should not simply rubber-stamp the phrase "audience consideration" on students' writing. Only by commenting in the right manner can students be aware of an audience's needs while writing.

(d) Use praise as a strategy

According to Thomas C. Gee (1972), students respond mostpositively to teachers' comments when they are praised in their work. These students tend to write more in the next piece of writing, have more patience and write better when they are praised. Therefore, teachers should attempt to use Compliments instead of making sarcastic comments or not commenting at all. However, teachers must also remember not to overuse praise. This action could lead to negative response instead of a positive one as students doubt the sincerity of such praises.

(e) Give **non-contradictory** messages, rank comments and be as specific as possible when commenting

As contradictory comments tend to confuse students, teachers should avoid such comments. Since the majority of students in Singapore do not all necessarily have a strong command of English giving simple and non-conflicting comments will enable these students to understand the required task better. Therefore, teachers should check their interlinear comments (comments between lines) and marginal comments (comments along a paragraph) to see that they do not conflict with each other.

Furthermore, teachers should rank their comments in students' writing. They can show the order of importance of each comment by listing all the comments in order or just numbering them. In this way, students will be able to know which first task to attend to in their writing.

In addition, teachers should also be as specific as possible in their commenting. By giving clear directives, students will be able to know what to do. Therefore, they will be able to revise successfully.

CONCLUSION

There are various ways to respond effectively and meaningfully to students' writing. The above suggestions are merely some of the suggestions that can be practised in the Singapore context. Teachers should ponder over the issue of the emerging paradigm on responding to students' writing and try to adapt some of these suggested strategies. Presently, what current research indicates is that a change of the present style of commenting is likely to enable students to carry out process writing more successfully.

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LANGUAGE LEARNING AND ENVIRONMENTAL EDUCATION

Review by
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INTRODUCTION

In recent years, the need for environmental education has been felt in many quarters, and many schools in both developed and developing countries have incorporated such a component in their syllabuses. Singapore is no exception. Recently, a sourcebook on environmental education in secondary schools was published by the Ministry of Education (Curriculum Planning Division 1994). This book provided an overview of the scope of environmental education in the formal and informal curriculum of the schools in Singapore.

What is not so well known however is that interest in environmental education is not just being promoted by the geography or science departments nor is it only of relevance to their curricula. It is now becoming an area of growing interest among language teachers. Such an interest can be seen in the formation of global education interest sections in their professional language teachers' organizations, such as JALT (the Japan Association of Language Teachers) and IATEFL (International Association for Teachers of English as a Foreign Language). Global issues and causes are also being established in many ESL programs as well as Masters degree courses. In Singapore, environmental themes have been included in the English coursehooks at primary and secondary levels. A workshop on environmental education in English instruction was organized by the Singapore Teacher's Union in 1994. It is now timely therefore to review the emergence of environmental education in language teaching and learning, as well as its methodological and pedagogical implications.

"GLOBAL", "ENVIRONMENTAL" AND "LANGUAGE" EDUCATION

Efforts towards educating students about the environment and involving them in activities to conserve nature are often classified as "environmental education", an area which falls under the broader category of "global education". In the past twenty years, environmental education has emerged in response to the realization that in many ways, for better or worse, the world is becoming increasingly interconnected and interdependent and is at the same time, threatened by a number of crisis such as the spoilation of rain-forests, the thinning of the ozone layer, acid rain, nuclear waste disposal, and exponential population growth.

That language teaching professionals should have taken to environmental education so quickly is not unusual. As Wilga Rivers (1976:96) puts it: "As language teachers we are the most fortunate of teachers - all subjects are ours. Whatever (the students) want to communicate about, whatever they want to read about, is our subject matter." Not surprisingly, the last two decades have seen language teachers preoccupied with "global" issues such as cross-cultural awareness training. "Women in TEFL" is also active in countering deep-seated and often unconscious prejudice on gender discrimination. Critical theory has been calling into question the ideology underlying the spread of English, asking questions such as "who does the teaching of international English ultimately benefit?" And the movement towards project work and involvement of learners with the community outside the classroom chimes well with a global perspective.

Incorporating environmental education (just as incorporating all the issues mentioned above) into the language syllabus is part of an aim to close the gulf between real life and classroom activity. There is a need to examine how language teaching connects with the work outside the classroom walls. There has so far been a separation of English language teaching from the mainstream of educational ideas; the lack of content as a subject matter. By making global issues a core of TESL and TEFL programs, the problem may be solved.

LANGUAGE TEACHING MATERIALS AND METHODOLOGY

Increasingly, we see content about the environment included in language teaching materials e.g. Avila, Morales, and Velasco, 1993; Chandrasegaran and Maclean, 1993; Brown, 1991. Most language lessons are planned in such a way so as to raise awareness of the problems, causes and the possible solutions to the problems concerned (Maley, 1992). Skills needed and taught through such materials are communication skills, critical and creative thinking, empathy, cooperative problem solving, non-violent conflict resolution and informed decision making. Language learning and practice is therefore learnt and obtained indirectly through a contextual discussion of a global issue of immediate concern to all the participants.

An interactive task-based integrative text for language learning is Stempleski's (1993) ***Focus on the Environment.*** Here, an all-skills focus is chosen as a means of learning English. This is done by using an accompanying video to act as a stimulus for a variety of viewing articles (including predicting, getting the main idea, listening for details, doing listening cloze passages and notetaking), exercises (focussing on vocabulary development through word puzzles, word games and getting the meaning from the context) and tasks (eg. debates, conducting classroom surveys, brainstorming, reading and writing assignments). The value of such a text is that it not only stimulates use of language by using authentic video, but also encourages students to go beyond the pages of their textbook to use English as a medium to talk about an important global concern.

Jacobs (1993, 1995) argued that in addition to including content about the environment, the language teacher should also consider the ***methods*** used in teaching that content. He pointed out that certain "pedagogical elements" lend themselves more to the integration of environmental education with language instruction. Summarized in the table below, these issues are 1) learner-centredness, 2) links with the communities where students live, 3) curricular integration, 4) thinking skills, *5)* teachers as models for students in common activities, and 6) cooperative learning.

Six ***issues related to sound environmental practice and sound pedagogy (Jacobs 1993):***

	Formerly Dominant View	Emerging Alternative View	Implications of Alternative View
1.	Nature and Students are Passive, Blank, and Need to be Controlled	Nature and Students are Active, Flourishing, and Independent	Learner-Centredness, Links with the Communities Where Students Live
2.	Diversity among Nature and Students is Ignored or Eliminated	Diversity among Nature and Students is Recognized and Encouraged	Learner-Centredness, Using Methods and Variety of Learning Styles
3.	Nature and Knowledge are Isolated and Compartmentalized	Nature and Knowledge are Contextualized and Integrated	Integrated Curriculum, Theme-Based Instruction
4.	Focus on the Product and the Short-term	Focus on the Process and the Long-term	Thinking Skills, Learning How to Learn, Intrinsic Motivation
5.	Humans and Teachers are Separate from Nature and Students, respectively	Humans and Teachers are Joined with Nature and Students, respectively	Teachers Serving as Models for Students in Common Activities
6.	A Competitive Atmosphere Prevails	A Cooperative Atmosphere Prevails	Cooperative Learning, Teaching Collaborative Skills

PEDAGOGICAL IMPLICATIONS

A case is therefore made that environmental education supports the emerging alternative view, which has already been adopted by recent language approaches such as the task-based approach, the functional approach, the communicative approach as well as the process approach towards writing. Some of the pedagogical implications following from these are:

1. Lessons should be cooperative in nature, preferably involving pair or group work, as these teach collaborative rather than competitive skills.

2. Teachers should use a variety of activities and methodologies to suit different learners since this encourage a recognition of diversity not only among students but in nature.

3. Lessons should be theme-based and the curriculum integrated in nature since this encourages students to relate school learning to their own lives and to be linked with the communities where they live.

4. Lessons should promote thinking skills since these enable students to see connections, to think deeply and to put their ideas into action.

5. Language should he taught by emphasising process rather than product since this not only gives students intrinsic motivation but also cultivates a long-term rather than a short-term perspective in students.

6. Teachers themselves will have to serve as "models" for students. They have to practise what they preach. This may mean being 'environmentally conscious' about the printing of handouts on both sides, and switching off lights when not in use, for example.

While the worldwide environmental crisis continues to worsen, this situation paradoxically motivates more and more language practitioners to join in the movement. As a result, we see the increasing integration of environmental education in all aspects of the curriculum, including language education. Today, language materials are increasingly featuring units on the environment, along with other global concerns. Learning a language is after all entirely in concord with learning how to express oneself on issues which concerns all humanity. Language learning is increasingly perceived as learning to communicate on issues that matter and are of common interest to one and all.

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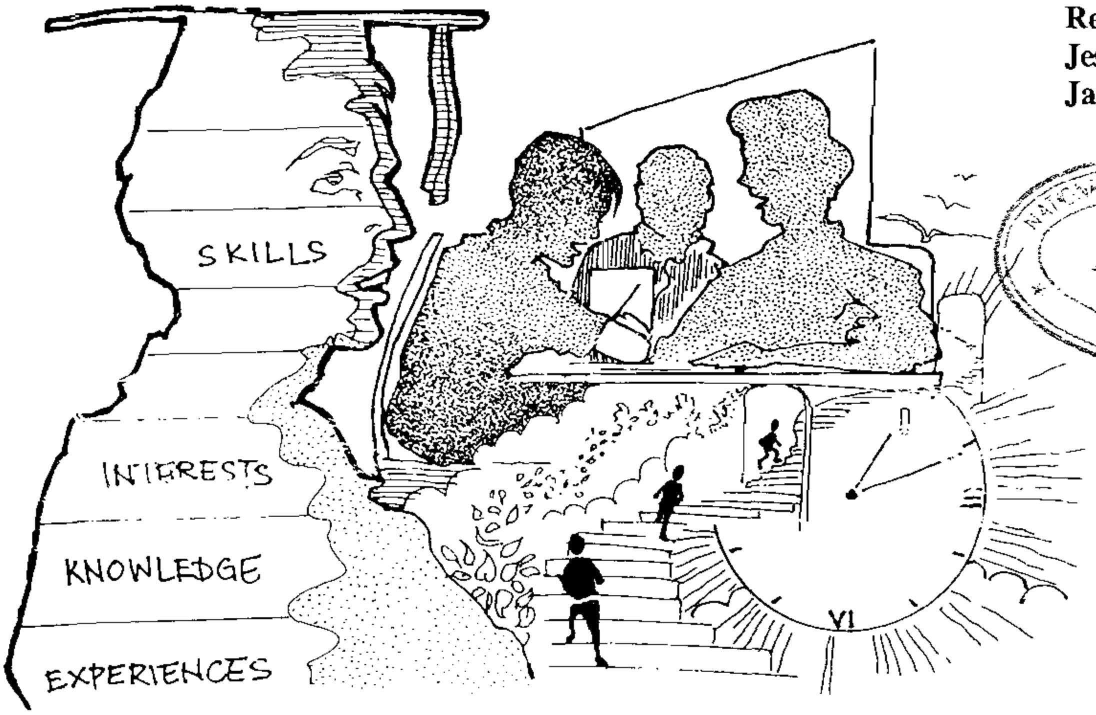
STUDENT PROFILING:
ONE APPROACH TO HOLISTIC, PARTICIPATORY ASSESSMENT

Review by
Jessica Ball
Jane Chia



INTRODUCTION

Student profiles, or 'pupil profiles', are documents compiled by teachers and their students, describing as clearly and broadly as possible the knowledge, skills, experiences, and interests of a student. Student profiles can be used as a multidimensional, participatory approach to recording students' progress longitudinally, across all levels of schooling. Recent research provides empirical evidence of the potential advantages of student profiling in helping to achieve some of the objectives of schooling in Singapore.

Education in Singapore has been increasingly characterized by the goal of supporting the development of the "whole child" and not just promoting achievement in academic subjects. Reflecting this holistic approach, efforts to monitor and record students' progress across areas of development have also increased in many schools in Singapore. Concurrently, there has been growing interest in finding ways to involve students in self-reflection, self-monitoring, and self-evaluation. For example, the Minister for Education has called for teachers to engage more in practices that will enable students to become independent learners (Lee, 1995). Fostering this kind of autonomy requires structured opportunities for students to develop skills in assessing their academic and personal strengths, discerning areas for improvement, and charting optimal paths for future learning.

EXAMPLES OF APPROACHES TO STUDENT PROFILES

A variety of content and procedures can be involved in student profiling. With reference to content, the developmental areas represented in the profile may be narrowly confined to the student's progress in specified subjects. At the other end of the spectrum, profiles may be broadly inclusive, encompassing aspects of the student's progress, accomplishments, activities, and personal characteristics both in and out of school (Hitchcock, 1986). When a teacher has a rich, detailed profile of a student's competencies, experiences, and needs, he or she is able to advise students more effectively about their plans of study, extracurricular activities, vocational choices and training (Gardner, 1993; Hitchcock, 1986; Stierer, Devereux, Gifford, Laycock, & Yerbury, 1993).

With reference to procedures for compiling the profile, entries in the profile may be restricted to contributions from teachers and other adults, made continuously or at the end of each school term. At the other end of the spectrum, profiles may be declared 'open records', and procedures may include structured opportunities throughout the school year when students are encouraged to contribute comments, autobiographical statements, plans, work samples, and/or records of their achievements in ECAs and out of school.

In Britain and Canada, profiles as 'open records' have been used with good effect as a basis for students to review their progress, identify their learning needs, make decisions about future learning objectives, and begin to discern their vocational interests and aptitudes (Davies, Cameron, Politano, & Gregory, 1992; Hitchcock, 1986). Also, investigators have reported that this type of collaboratively constructed documentation is useful as a shared focus for teacher-student dialogue and teacher-student-parent conferencing and decision-making about how best to support the student's development through learning experiences in and out of school (Davies et al., 1986; Hitchcock, 1986; Stierer er al., 1993).

Current research suggests that, ideally, a student profile is broadly but succinctly inclusive of all aspects of a student's growth as a person as seen from the "observer" perspective of teachers, administrators, and ECA leaders, and from the "insider" perspective of the student him/herself (Davies et al., 1992). This type of holistic, participatory approach to student profiling has been used most extensively as part of the Pastoral Care movement in Britain. There, teachers have found it to be an effective way to involve students in assessing their own learning and, at the same time, to provide a more well-rounded view of students than that yielded by scores on national examinations (Hitchcock, 1986).

REVIEW OF RESEARCH

A review of research in education shows that there can be many advantages of student profiling, especially when profiles are designed to be multidimensional and to allow some student input.

1. Refleetine a differentiated view of the Self. There is a powerful motivational and esteem-building impact of allowing formal recognition of students as multidimensional, changing individuals with varying degrees of strengths and areas for improvement across domains (Davies et al., 1992; Gardner, 1993; Raffini, 1993). Research has consistently shown a positive relationship between self-esteem and motivation to achieve in school (Raffini, 1993).

2. Promoting self-monitoring. Students need to be able to monitor their progress and identify their own learning needs in order to become the kind of flexible, self-reflective, independent learners described by Education Minister Lee (1995) and others who have considered the pedagogical implications of rapidly expanding and continuously changing knowledge resources and skill demands. When students are invited to participate in profiling, for example by reading it, commenting on it, contributing to it, or discussing it with a teacher, they are given tangible evidence about their progress and about how others see them. The more opportunities students are given to be actively involved in constructing their profile, the more the expectation is conveyed that they are active, accountable learners with capacities for meaningful self-reflection and selfdirection (Davies et al., 1992). Research has shown that when students accept personal responsibility for their developing competencies, their emotional involvement and commitment to learning increases. Also, they are likely to try harder to refine and selectively apply their learning strategies, and to make internal attributions when they succeed (Raffini, 1993).

3. Cross-disciplinary communication. Research has shown that formal adoption of a system of recording students' progress longitudinally and across domains tends significantly to increase cross-disciplinary communication in a school (Stierer et al., 1993). Profiling can provide a motivational and organisational framework for staff cooperation on: (a) monitoring and recording cross-disciplinary

skills, interests, and needs; and (b) devising, implementing, and evaluating plans for helping individual students with special needs (Davies et al., 1992; Hitchcock, 1986).

4. Home-school links. Research has shown that parents are more likely to be involved in positive ways in their children's school life when they are kept informed about their child's activities and progress in school (Davies et al., 1992; Raffini, 1993). In Britain, the United States, and Canada, positive effects have been reported for innovations in which the teacher and/or student has periodically shown and/or discussed the student's profile with parents (Hitchcock, 1986; Stierer et al., 1993). In Singapore, some principals have commented on the utility of profiles when meeting with parents, especially since they cannot get to know every student individually. In the profile, the consolidation of a range of information about the student can help principals to present parents with a cohesive view of the student's progress and needs across academic, psychosocial, psychomotor, and vocationally-relevant domains.

5. Enhancing students' career readiness. Student profiles can further the goals in Singapore of clarifying links between schooling and careers and enhancing students' career readiness. When students are invited to review and contribute to their profiles, they gain self-knowledge and are better able to articulate their vocational interests and goals (Hitchcock, 1986). Also, student profiles may include vocational interest and aptitude inventories, as well as worksheets where students may record their vocational interests and goals. In some countries, profiles have been used to good effect as a resource for students to prepare applications and role-play practice interviews for subsequent educational institutions or jobs (Davies et al., 1992; Hitchcock, 1986).

CONSTRUCTION AND INNOVATION OF STUDENT PROFILES IN SINGAPORE

Since students profiles are best used as multidimensional and longitudinal documents of record, they are highly compatible with the holistic and developmental aims of the Pastoral Care and Career Guidance (PCCG) movement in Singapore. The PCCG Branch and the Examinations and Assessment Branch of the Ministry of Education have supported decisions by individual schools to introduce a system of student profiling as part of their implementation of PCCG. It has been stressed that, in keeping with the the 'whole-school' scope of PCCG, innovations in student profiling should include all students, and not be used only to monitor students with special needs (Ministry of Education, 1995).

A detailed, multidimensional "Pupil Profile" was developed by the Ministry of Education and piloted in primary schools in 1991-92 (Ministry of Education, 1992). This prototype has been adapted by more than forty primary schools. At the same time, the Ministry of Education has urged schools to devise profile forms and procedures that will be maximally useful and feasible in terms of paperwork and other practical requirements; profiling should not become a compulsive system of record keeping for its own sake (Ministry of Education, 1995). Indeed, virtually all commentators and researchers on effects of student profiling innovations agree on the importance of tailoring profile materials and procedures to reflect what is important and feasible to the teachers and students in each school (Hitchcock, 1986).

In Singapore, where there are many similarities among schools at each level with respect to the curriculum, examinations, and ECA offerings, there could conceivably be considerable similarity among schools with respect to the academic content of student profiles. However, schools are likely to vary in decisions about the kinds of psychosocial and other content that is considered important, and about the kinds of student contributions to their profiles.

Another type of contribution to profiling in Singapore is currently being made by a group of researchers that bas been designing and piloting test materials intended to help characterize a student's developing competencies across learning situations (Wong, Sim, & Tay-Koay, 1993). For example, part of this 'Pupil Profiling' initiative has involved pilot testing an original 'Learning Abilities and Dispositions' instrument to track students' memory capacities, self-concept, problem solving, and visual perceptual processing (Wong, 1992).

Whether narrowly or broadly conceived, the unifying objective of profiling is to provide teachers, students, and parents with an integrated, differentiated view of students' development in a way that students and teachers can use to monitor progress over time. Teachers interested in designing and innovating a profiling system in their school need to consider what is feasible in terms of the amount of paperwork and processing time needed, what dimensions of students' development it would be useful to monitor, and how students will be involved in contributing to and reviewing their own profiles (Hitchcock, 1986; Stierer et al., 1993). In addition, decisions need to be made about whether profiles are to be 'open records' and what activities will be used to actively involve students in ongoing construction and review of their profiles (Davies et al., 1992). Consideration should also be given to using profiles as summative records that can provide a differentiated portrait of students' learning and all-round development to parents, prospective employers, and other educational institutions.

CONCLUSION

In Singapore, significant inroads in the exploration of alternative student profiling formats and procedures have been made in some schools at the primary, secondary, and tertiary levels. The use of holistic, participatory, and longitudinal student profiles can contribute significantly to achieving the developmental aims of PCCG and the pedagogical aim of helping students to become independent, adaptive learners.

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STAYING ON TOP: MAINTAINING TEACHING SKILLS

Review by
Dennis Rose

INTRODUCTION

It used to be fashionable to ask why Johnny couldn't read (Flesch; 1966). More recently another question has emerged: Why can't Johnny's teacher teach? (McLaughlin, Pfeifer, Swanson-Owens, & Yee, 1986). As parents and communities demand greater accountability in education, the focus has shifted from the achievement of pupils to the performance of their teachers and schools.

Is it reasonable to hold teachers solely accountable for pupil achievement? Teaching is diverse and complex. Every day teachers engage in numerous professional and interactive actions. Brophy and Good (1986) describe an effective teacher as one who has control of the learning context, organizes and paces lessons well, and engages pupils meaningfully in curriculum **tasks.** They are active, enthusiastic, and clear communicators. These teachers question and challenge pupils with regard to difficulty and cognitive level. They give clear directions, instruct logically, encourage, prompt, give feedback, discipline, and listen.

Berliner (1983) identified an additional group of tasks that he called "executive functions'. These include planning, communicating goals, managing classwork, creating a pleasant working environment, supervising and working with others, and evaluating the performance of those being supervised.

Teachers do most of these things without ongoing support. The act of teaching is rarely witnessed by colleagues. How can a teacher stay on top of the teaching task when it is so complex, so busy and so isolated?

In this paper four areas that teachers may consider when seeking strategies to maintain their skills are identified. These areas are: observation and support, practice, gaining knowledge about the effects of their teaching, and structured programming.

OBSERVATION AND SUPPORT

Teaching is a solitary profession and teachers often receive little or no support from their colleagues and supervisors. However, teachers respond to recognition by others. For example, Hopkins and Conard (1975) trained teachers to double the amount that their pupils learned in mathematics, reading and spelling. However, once the experimenters left the classrooms, the teachers soon went back to their old ways. Principals were then trained to observe teachers teaching and to provide them with information about their teaching. This maintained the teachers' use of effective practices @angel, Conard & Hopkins, 1978). Then a new problem emerged (Hopkins, 1987): the principals needed someone to maintain their support of the teachers! The results of these and similar studies are unequivocal: teachers continue to use their skills when they receive monitoring, feedback and support.

Suggestions for teachers:

* ***Ask a colleague to observe you teaching. Choose a specific aspect of your teaching and ask for feedback on it. Ask your colleague to simply give you the informarion about what you did rather than her opinion of you as a teacher.***

* *Form a small group of teachers to discuss aspects of teaching and ways in which it could be improved. Observe one another teach and meet to exchange information. It is important that such information is treated confidentially and is free of judgments. The aim is to support and encourage.*

* *Set yourself simple goals such as asking probing questions or using wail-time. Record your use of them using a tape-recorder or a wrist-counter.*

PRACTICE

Skill practice has long been regarded as essential for fluent performance. This is well accepted in music, sport, and acting and it is increasingly regarded as essential for many professional tasks. Engelmann (1988) asserted that about six months of periodic practice with supervision are required before teachers become proficient in the classroom. A review of the acquisition and maintenance of teaching skills identified skill practice with performance feedback as the only training strategy that consistently improved teacher performance (Rose, 1994).

Suggestions for teachers:

* *Set a goal to improve your use of one teaching strategy. Make some reminders for yourself such as a note on the back of your hand or on your desk. Count the number of times you use the strategy over a fired period of time with a tally mark or a counting device such as a wrist-counter. Make a graph of your daily performance and see if it is improving.*

* *Tell one or two of yourpupils that you want to increase your use of a particular strategy and ask them to remind you to use it. The pupils might even record it for you.*

INCREASING KNOWLEDGE OF THE EFFECTS OF TEACHING

Increases in pupil achievement do not seem to be sufficiently reinforcing to teachers to maintain their teaching skills (Hopkins, 1987). A possible explanation for this is that pupil achievement is usually measured infrequently and with broad measures whereas teachers are actively engaged in an ongoing stream of discrete actions. The link between specific teacher actions and the direct effect of those actions on pupil learning is rarely apparent.

It is possible that teachers' use of superior teaching methods would be maintained if they were exposed to a continuous stream of information about the direct effects of their teaching. Some teacher preparation programmes place an emphasis on observation skills and repeated measures of pupils' learning (e.g., Maheady, Harper, Mallette, & Karnes, 1994). Teaching practices such as precision teaching routinely generate such information (e.g., Lindsley, 1990). Greer (1994) described a method of recording the rate and accuracy with which teachers presented learning opportunities to pupils. He and his colleagues found that when direct teaching was the focus of observation, both pupils and teachers learned.

Suggestions for teachers:

* *Collect on-going information about how your pupils work. At a given moment, how many of them are on-task? During lessons, how many ask questions? How many pupils complete all of their work in class time or do their homework?*

* *Regularly collect information about the accuracy and rate of your pupils' classwork.*

* *Graph this infonnaiion and ask yourself whether it could be improved? What changes in your reaching might be necessary to cause such improvements? When you alter your teaching, monitor the graph to check rhar you are having the desired effect. You may want ro involve pupils in collecting and graphing rhe informaiion.*

STRUCTURED PROGRAMMING

Pupil learning often improves when teachers routinely follow a structured pattern. For example, Good and Grouws (1979) developed a routine for fourth-grade mathematics classes. Lessons began with a daily review of homework, some mental computation and special weekly and monthly reviews. Topics were developed as whole-class lessons of 20 minutes and pupil understanding checked. Pupils were then given about 15 minutes of uninterrupted successful practice. The lesson concluded with the assignment of about 15 minutes of homework. After only a few months, the teachers who consistently followed this simple routine increased their pupils' performance from the 27th to the 58th percentile on national (USA) norms. The teachers who adhered most closely to the structure had the best results.

Examples of increased pupil achievement from structured programmes abound (e.g., Johnson & Layng, 1994; Lindsley, 1991). When teachers are presented with clear objectives and straightforward ways of achieving them, they are more likely to produce improved educational outcomes for their pupils.

<u>Suggestions for teachers</u>:

* *Develop a routine for your lesson.. If you and your pupils know what to expect, you can all devote more of your attention to the content of the lesson.*

* *Arrange your programmes so that you can provide for regular review of work from the previous week and month.*

* *Identify structured programmes in your area. For example, precision teaching and direct instruction procedures have had high levels of success in most curriculum areas, in special education and in regular education and with pupils of all ages.*

CONCLUSION

Much is expected of teachers. The expectation that every teacher must succeed with every pupil is unrealistic. Nevertheless, teachers can extend and maintain their teaching skills by:

* *working with other teachers to gain information about their own teaching,*

* *explicitly identifying and practising aspects of their teaching,*

* *becoming better informed about the effects of their teaching on their pupils, and*

* *arranging the teaching task into routines.*

There are some implications for principals in this paper. Principals wuld support their teachers' efforts to maintain and extend their skills by encouraging them to collaborate with others and by providing time for them to make observations of other teachers. They could also provide inservice training in observation and collaborative skills. Teachers are unlikely to voluntarily expose themselves to observation if they feel that information gained in this way could be used against them. Principals can encourage collaborative work between teachers by creating a climate of trust.

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CULTURALLY RESPONSIVE EDUCATION FOR UNDERACHIEVERS

Review by
Rosalind Y Mau

NTRODUCTION

Teachers know that some students have a knack of learning well while others struggle with eading, writing, listening, and/or doing mathematics. Underachievers who are unmotivated and are not iorking to their full potential need strategic help from teachers. Recent research and programmes have xplored culturally responsive education in increasing motivation levels, developing learning strategies, nd promoting self esteem of students from various cultural groups (Gollnick and Chinn, 1994; Baum, lenzulli and Hebert, 1994; Podell and Soodak. 1994). Culturally responsive education works in the lassroom because teachers use what is known of students' own culture(s), including peer culture, to evelop educational practice. This review focuses on how teachers can structure social relationships and se various teaching styles to enhance learning for underachieving students in a multicultural society.

VHAT RESEARCH SAYS

Research studies have focused on underachievers from various cultural groups because of the reponderance of particular groups in remedial classes and slower-achievement tracks (Gollnick and Chinn, 1994; Au, 1990; Bennett, 1986). A review of the work linking underachievement and culture ielded studies focusing on the critical role of teachers (Baum, Renzulli and Hebert, 1994; Podell and oodak. 1994), teaching and learning style compatibility (Banks, 1994) and using the students as esources (Vegas, 1994).

Critical role of teachers:

Teachers play an important role in reversing underachievement through culturally responsive education. Baum, et al (1994) suggested that these teachers recognize the problem and identify strategies to help underachievers overcome their difficulties. Podell and Soodak (1994) concluded in their study "that teachers must not only believe that the intervention they are suggesting can be effective, but they must also have confidence in their ability to implement the intervention effectively" (p. 50). So culturally responsive teachers know that it is not just about *what* students are taught, but *how* students are taught.

Home and school link:

Research has shown that culturally compatible school programmes enable students to achieve academic goals through means consistent with the values and standards for behavior in the home. For example, certain cultural groups attach great value to the well-being of the group. The ability to work with others is judged to be more important than an individual's achievement. In contrast, schools typically place a greater value on individual achievement (Au, 1990). Two studies have found an inconsistent socialization and values link between Hawaiian homes and schools (D'Amato, 1988; Gallimore, Boggs, and Jordan, 1974). Because of the necessity of linking the socialization patterns of the home to the school, James Banks, a leading proponent of multicultural education, advocates a variety of teaching styles that are compatible with learning styles of different cultural groups (Brandt, 1994). In other words, culturally responsive teachers need to use a myriad of teaching styles to meet the various learning styles underachievers bring with them.

CULTURALLY RESPONSIVE EDUCATION FOR UNDERACHIEVERS

There are two important components of culturally responsive education: the use of a variety of teaching styles and curricula in order to meet different learning styles, and understanding the cultural resources students bring to school.

Understandine the cultural resources of students:

When teachers reflect on their own teaching and how they view their underachievers, they take their first steps toward culturally responsive education. Firstly, do teachers believe that all students including underachievers can contribute to society and therefore have high expectations for them? Secondly, are teachers willing to share their power with underachievers by adapting instruction to students' cultural backgrounds? By relating new knowledge to the students' own experiences they show underachievers how the content area affects their lives and how it can be related to what they already know. In this way, underachievers are more motivated to make the connection between their own experiences and build upon what they know to what is to be learned.

Using a variety of teaching styles and cultural curriculum:

Although within-group differences exist, generally different cultural groups prefer certain learning styles. Some respond better to collaborative, hands-on approaches and others favour individual, lineal learning. Yet some have a greater proclivity to a visual or kinesthetic approach while others prefer oral discourse and active dialogue. Socialization within a particular culture shapes the way students learn and what ideas are important. For example, some home cultures condition children to approach learning holistically, but in schools knowledge is taught in parts (analysis) and by seeing the relationships among the parts (synthesis). Furthermore, underachievers often learn better when they have a personal relationship with the teacher and can interact with their peers rather than work independently on their own. Teachers who are aware of the various learning styles and use a variety of teaching styles are better able to motivate and meet the needs of underachievers academically and socially.

Moreover, teachers who augment their curriculum with stories from the student' own culture and experiences, empower the underachiever to learn and progress to their full potential.

Besides the cognitive domain, self esteem in the affective domain is enhanced. Research has shown that culturally responsive education raises the self-esteem of underachievers, a key factor to improving student performance (Powell and Makin, 1994; Bennett, 1986).

IMPLICATIONS

Two overriding goals of culturally responsive education are to develop a belief that teachers can understand and use the cultural resources of the students and their parents. Cultural resources are students' values and experiences, approaches to learning, learning styles, and interaction patterns (Vegas, 1994). The second goal is to promote a culturally relevant pedagogy in terms of structuring social relations in the class and using a variety of curriculum and teaching styles (Gollnick and Chinn, 1994).

Teachers are effective in the classroom when they realise that every student can learn and they take measures to reach the underachievers. First and foremost, teachers must have the confidence in their ability to use a variety of teaching methods to meet the salient learning styles of the underachievers (Podell and Soodak, 1994). For example, teachers can structure social relations by varying their teaching styles:

1. Introducing a lesson through a hands-on activity to motivate underachievers who enjoy more concrete, manipulative activities.

2. Lecturing on the basic concepts and vocabulary using visual aids to provide a framework for students who like to listen and take notes.

3. Applying the concept through an academic task completed in cooperative learning groups where students can learn from peers.

Besides using varied teaching styles and methods, multiple assessment methods would also benefit underachievers such as checklists for oral reading and reports, research papers, and anecdotal records. The learning log, is a practical assessment method for underachievers. It is written by individual students at the end of the lesson. The teacher requires that students summarize what they have learned from the lesson and then the teacher gives feedback in the logs as to what is comprehended well and/or clarifies students' misunderstandings.

CONCLUSION

Culturally responsive education grounded in research studies of various cultural groups has een successful in helping underachievers in a multicultural society reach their full potential in schools. Research points to elements of culturally responsive education where teachers are aware of their own beliefs and feel they can intervene to help underachievers from different cultural groups, use various teaching styles, and focus on the resources student bring to classroom, examine the wide range of learning styles of their underachievers and implement various teaching styles, and promote a stronger link between home and school. The link can promote parental involvement to support undereracheivers in completing academic tasks.

On a societal level, an educated population is a pre-requisite for continued growth of Singaporean society. The basic policy of schools is to educate students to their full potential in order to effectively and efficiently use Singapore's most valuable resource - namely its people. So although culturally responsive education can serve high achieving students, it is especially valuable for underachievers in a multicultural society.

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Review of Educational Research and Advances for Classroom Teachers

REACT

REACT (standing for Review of Educational Research and Advances for 'Classroom Teachers) continues the task of keeping teachers, senior school personnel and principals abreast of advances in research in education. ***REACT*** attempts to ***link*** research to practice by presenting ***reviews*** of areas of interest. Each review covers two or more research studies related to a particular topic. The review writer also teases out significant implications for practice.

REACT is addressed to a wide readership of practitioners in education. In the interest of communicating with this wider audience; technical details of research and the jargon that goes with the subject will be reduced to a minimum consistent with the integrity of the data. Readers who want to know more details are referred to the original research reports and studies cited under ***Sources*** in each review.

Nine articles are included in this issue of ***REACT***, ranging from reviews of curriculum methods, materials and assessment in mathematics, science and language, to a thought-provoking discussion on how teachers can stay on top of the teaching task and maintain their teaching skills! Research reviewing how race, SES and sex differences affect student achievement in mathematics is also presented together with a discussion on enhancing learning for underachieving students in a multicultural society. An article on the advantages of 'pupil profiling' is also included, together with a review of the emergence of environmental education in language teaching and learning.

The Editorial Board welcomes contributions for future issues. Articles must be received by February 1 for the May issue and August 1 for the December issue. Send articles to: The Editor, ***React,*** Nanyang Technological University, 'National Institute of Education, **469,** Bukit Timah Road, Singapore **259756.**

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