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A Vision for Effective Teaching

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Effective teaching goes beyond such ubiquitously emphasised attributes as mastery of subject, enthusiasm in preparing and presenting the material, effective voice control, friendly mannerisms, organised lecturing and appropriate audience management. Careful examination reveals that these attributes rest upon more fundamental principles classified under the following five categories:

- **A**bsolute commitment
- **B**eing a good example
- **C**haracter ethic
- **D**ynamics of student-teacher interactions
- **E**ffective communication

Just like watering the root of a tree automatically nourishes its branches and leaves, similarly, addressing the foundational principles will 'nourish' the features and skills of effective teaching. This article will hopefully provide some food for thought, help teachers identify the 'root' of effective teaching and 'water' it.

A—Absolute Commitment

The modern university environment places numerous demands on teachers. In such a scenario, often combined with strong negative learning attitudes of students, effective teaching requires a teacher's absolute commitment to the task.

A committed teacher's responsibilities go beyond ensuring good classroom performance of the students. Apart from sustaining the students' interest in the module (course), a teacher must impart an interest in the overall process of learning and help students acquire the ability to analyse new situations with the help of classroom principles. Students must also learn to appreciate the proper and improper uses of the knowledge transmitted in a module. Besides curriculum learning, students' attitudes and character must receive attention as well. For instance, issues relevant to eco-friendliness can be addressed as part of the course.

In addition, a committed teacher considers the welfare of his students and (consequently) of humanity a priority. He (she) is not allured by high positions, fame, money and so forth. He is focussed on the long-term effectiveness of his contribution. A teacher's true representative student is a testimony of the teacher's contribution, investment, satisfaction, and in fact, the teacher's very life. Such an achievement certainly requires the teacher to invest more than just 30–40% of his time. Although few current universities truly recognise this, a committed teacher perseveres to achieve his exalted goals.

B—Being a Good Example

Teaching (learning) does not take place merely when deliberate instructions are being given or when specific

continued next page...

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topics are discussed. Subtly, the teacher's behaviour and internal attitude can get transplanted into the students' hearts. Therefore, the teacher must be an enthusiastic and avowed learner, especially when it comes to new material.

There are two possible learning responses to the example set by the teacher:

- *Imitation*

  For example, if the teacher is clumsy, lazy, apathetic or tardy, the students will copy such negative attitudes. However, a punctual, well-organised and enthusiastic teacher inspires these positive qualities in his students.

- *Inference*

  If a teacher is intolerant of mistakes, students will soon infer that mistakes are not welcome. This can cause students to freeze from attempting novel ideas, thus seriously hampering learning.

Effective teaching occurs when teachers demonstrate and model components of exemplary teaching such as thinking and analysis, beliefs, curiosity and learning. An expert teacher is always aware that students are constant observers of his own attitudes, principles and beliefs and strives to set a good example.

C—Character Ethic

While the personality ethic focuses on external values, behaviour, skills, and techniques with short-term, quick rich goals, the character ethic focuses on motives and principles, as well as long-term sustainable goals.

An effective teacher must reject the temptations offered by the personality ethic in favour of the actual gains that will accrue in time with the character ethic. Working with students requires the teacher's deep commitment that is only possible in consonance with the character ethic. Patchwork solutions produced by the personality ethic are like painkillers for an acute disease; the problems might be temporarily hidden, only to return later with a vengeance.

A teacher must personally manifest such principles of the character ethic as humility in erudition and success, tolerance towards others' mistakes, courage in pursuit and dissemination of truth as well as simplicity and contentment in one's work. He is happy at others' success, clean in thoughts, speech and behaviour, and deeply committed to actual knowledge

D—Dynamics of Student-teacher interactions

Effective teaching depends heavily on respecting the students as persons and not merely as numbers. Knowing the names of students, their personal strengths and weaknesses, and in special cases, something about the student's family, can be extremely helpful in building a platform for meaningful interactions. By looking at each student during a lecture and spreading out questions and answers among several students, teachers can create a conducive setting for interpersonal exchanges. Talking too much into the blackboard and ignoring students create an overall impersonal effect.

Students will need specific encouragement and corrections to remain interested in the subject. In general, however, best results come from maintaining a positive atmosphere, avoiding sarcasm, and offering timely encouragement and suitably measured corrections. Acknowledge good work or behaviours with comments that are precise: "Your work is *original*", "I was *delighted* to read your paper", and "Your paper was second best in class". Avoid generic eulogies: "You are great!", "Well done!".

Creating good student-student dynamics is also very helpful in enhancing student-teacher interactions. Group work and exercises in experiential learning may be used effectively in this regard. Measured informal exchanges outside classroom are also helpful.

Teachers may be classified as assertive, non-assertive and hostile. Assertive teachers are dutiful, hardworking, whose enthusiasm does not waver with student performance/ interest. Such teachers specify consequences and reward precisely and appropriately. Non-assertive teachers also work hard, but their determination depends heavily on student performance and they do not clearly spell out consequences and rewards. Hostile teachers get angry, give unrealistic consequences and seldom reward positively. They force the students without inspiring them and seldom set a proper example themselves. It is not uncommon to find all three teacher-types in one teacher.

An effective teacher who strives to stay on the assertive platform needs to invest an enormous amount of time, resources and energy. It is on the assertive platform that meaningful and sustainable student-teacher relationships are built. In turn, such relationships form the basis of a lifetime of reciprocal learning.

E—Effective Communication

Effective communication of knowledge can only take place based on genuine love, care and concern. Learning is not merely a development of skill sets; it involves moulding of thoughts, analysis, and attitudes, inculcating a zeal for learning, and long-term character development. Communicating information (e.g. in most distance-learning programmes) is relatively simple, and could be achieved without much personal touch. Classroom teaching goes beyond the transmitting of information from the teacher to the student.

On the basis of love and trust, most students feel automatically inspired to become effective learners. A loving teacher can extract much more input and output from the students than a strict disciplinarian. On that platform, students can be challenged with thoughtful exercises, given innovative assignments and induced to work honestly in teams.

continued on page 18...

Motivating Students in a Writing Class

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Introduction

Motivating students in a language class is a perennial problem, especially for English proficiency teachers at our centre. This is because our students have experienced failure communicating in English and thus, tend to have low motivation towards the course. Also, students are often resentful about taking an additional course to improve their language skills. Although all of our students have been determined to be weak in English, their standards differ—weak, weaker, weakest.

We have a good idea of how to teach these students. However, the question that constantly engages us is how can we help our students learn better? In "English for Academic Purposes" (EG1471), a compulsory writing course for engineering students who fail the university's Qualifying English Test (QET), we have used the writing portfolio and small-group learning to help our students learn. In Semester Two (AY 2001/02), we studied the effects of these strategies and found that they had positively influenced and motivated the students.

Portfolios and Small-group Learning

EG1471, a 48-hour, one semester course, focuses on improving students' writing. Since research on writing portfolios and small-group learning indicate that such strategies enhance learning, we used them in our course with some adaptations to suit our needs. We assumed that if students found these activities helpful and enjoyable, they would be more motivated to learn and become better writers.

Portfolios

A writing portfolio is typically defined as a collection of a student's best work and implies that the student is able to discern good writing. The following benefits and aspects of a portfolio are most relevant to us:

- Demonstrates the effort that the student has put into his writing. This effort can be seen in the quality (and in some cases, quantity) of work presented.
- Contains some student reflection. Students are used to receiving our feedback but do not often reflect on their strengths and weaknesses as writers. Reflection generated by a portfolio helps students focus on areas that they have improved in and those needing more work.
- Requires students to be more aware of what constitutes good writing as they need to put their best work in the portfolio. Thus, students are 'forced' to become more analytical about writing in general and their own writing in particular.
- Reflects the students' understanding and knowledge of the effort that went into their work.

We adapted the portfolio to meet some of our needs. Most importantly, we asked our students to include ALL the work they did during the semester in their portfolios. Unlike the typical writing portfolio, ours served another purpose: since our students were not required to attend classes, the portfolio was a record of all the work they did. To us, the amount of work indicated the students' level of participation and attendance in the course.

At mid-semester, we asked the students to reflect on the progress they had made AND on their behaviour with regards to participation and attendance. This was part of our attempt to make the students aware of their responsibility for their learning.

Finally, although the students needed to include all their work in their portfolios, they still needed to select their three best pieces of writing for a grade. While the teachers reviewed and gave feedback on everything that was included in the portfolio, they graded only the three texts the students chose.

Small-groups

In small group learning two or more students work together to accomplish structured common tasks. In carrying out these tasks, students use cooperative, pro-social behaviour (i.e. collaboration, not competition). The students are individually responsible for their learning (Millis, 1996)—knowledge is created through interaction instead of transmission of information from the teacher.

Nowadays, the value of small-group learning is generally accepted and seen to offer many benefits. Those relevant to our course are:

- Development of higher-level learning and problem solving skills;
- Development of interpersonal and group skills;
- Enhanced practice hence improvement of communication skills, and increased motivation for and enjoyment of learning.

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We used small-group learning in the following three areas of students' course work:

- Gathering ideas for their writing through brainstorming and discussion of readings chosen by students;
- Discussing grammar problems; and
- Revising their writing through peer review.

Evaluation Portfolios and Small-group Learning

We ascertained how students regarded portfolios and small-group activities in terms of helpfulness to their writing and enjoyment as learning activities by analysing five sets of data:

- Surveys of student perceptions;
- Student writing samples;
- Student self-assessment;
- Informal interviews; and
- Our own observations.

Portfolios

About 75% of our students found portfolios a helpful strategy for improving their writing. However, only 50% indicated that they enjoyed the process of keeping and putting the portfolio together.

Our interviews with students gave us more insight into their feelings about the portfolio. Most students had a high degree of personal satisfaction with their portfolios. They felt and could see that they had accomplished a lot during the semester. Students also saw their problems and how they overcame some of them to become stronger writers. This gave students a great amount of satisfaction. Although they felt it was difficult to select which work to be graded, the exercise was helpful as students had to use all their knowledge about writing and it made them feel responsible.

As teachers we found that, firstly, portfolios are a good reflection of our students' work and effort. Those who worked hard (and attended class regularly) had more pieces of writing and group work in their portfolios than those who had not. Secondly, it was easy for us to see our students' progress from the portfolios. All the work throughout the term was included so we could compare work from the beginning and the end of the term. Thirdly, even though many of the portfolios were rather 'thin' at mid-semester, students rallied and pulled together mostly good portfolios by the end. In the process of putting their portfolios together, students began to feel good about what they were doing and many worked to develop complete and attractive portfolios. The only negative aspect was that some students had difficulty organising their work, thus making it difficult for them—and us—to track their progress.

Small-group Learning

In general, our students found group planning and peer review helpful. They also enjoyed the group reading activities. In particular, peers' comments made the writers more aware of their reader's point of view and helped them in the revision process. The suggestions for improvement were also welcomed because these revealed weaknesses the writers had overlooked. Group grammar work was, however, the least favoured activity.

It was evident that students found choosing their own readings and topics for discussion most enjoyable, though they sometimes found decision making difficult. The light-hearted discussions helped the students relax. Even when the discussions digressed, students noted that these distractions helped them get to know each other better. The discussions not only exposed students to other interesting points of view but also helped them gather ideas and more examples to use in their writing. Also, the discussions forced students to use English in class and consequently improved their language skills. Although most of our students enjoyed and found these small-group activities helpful, we observed that this was true of only some groups and selected tasks (i.e. discussion of reading selections and peer review).

Some difficulties in group work noted by students included attendance problems; lack of group rapport; irresponsibility of group mates; inability to deal with grammar questions and logistics.

Generally, we noted that successful groups had the following characteristics:

- Members were usually present in class and they generally came prepared. Thus, they would usually be actively engaged in discussions or peer review during the group activities hour.
- Members also tended to be friendly with each other, and generally sat together in class. Whenever group exercises (e.g. a team oral presentation) were assigned, they usually did better than the rest.

It seemed that the members' positive engagement in their group activities bred success, which then fuelled their desire to continue working together as a group.

Conclusion

The use of the writing portfolio in EG1471 has been effective in instilling student pride in their work. It gives them a tangible record of their work (by showing the successes and failures) and consequently a clear direction to follow towards becoming better writers. Small-group learning activities can provide students who are poorly motivated with much needed support in a writing class. Besides additional information and alternative points of view, it can offer camaraderie through the difficult and often frustrating process of writing.

References

Burch, C. (1999). 'Inside the Portfolio Experience: The Student's Perspective'. *English Education*. Vol. 32, pp. 34–49.

Channiam, S. 'Nurturing Students to Learn Writing Skills through Portfolios'. *Thai TESOL Bulletin* 11. http://www.thaitesol.org/bulletin/1102/110204.html/. (Last accessed: 8 May 2003).

Crookall, D.; Lopez-Nerney, S.; Teng, S.M.; Wu, S.M.J.; Toh, L.S.J.E.; Norhayati, M.I.; Meyer, L. & Jacobs, G. (2000). 'Student-initiated Out-of-class Academic Collaboration at a Singapore University'. *The Asia Pacific Education Researcher*. Vol. 9, No. 1, pp. 64–82.

continued on page 9...

Peer Tutoring—An Effective Strategy to Promote Student-centred Learning

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Peer Tutoring is the system of instruction in which learners help each other and learn by teaching (Goodlad & Hirst, 1989). Also known as 'Cross-age Tutoring','Youth Tutoring Youth', and 'Each One Teach One', peer tutoring *i*s one of the most effective methods in promoting student-centred learning. The main task of the professional teacher is to facilitate the activity of the non-professionals (student-tutors) as they teach their peers (tutees).

In practical terms, this means that the professional teacher is responsible for introducing seminal readings and discussing them with the student-tutors. The professional teacher should also guide and give feedback to the student-tutors before and after the tutorial. In addition, some time should be set aside at the end of each tutorial for the tutees to clarify certain points with the professional teacher or comment on the student-tutors' effort. Teaching by the student-tutors comprises a short presentation followed by a class activity led by the student-tutors. From my personal experience, peer tutoring is beneficial in helping students learn actively in a setting that promotes multiple-intelligences (Howard Gardner, 1993). The following are some useful strategies adopted by my students in their peer tutoring.

Student-tutors' Presentation

Student-tutors present the salient points of their research topic with the help of whiteboards, OHTs, PowerPoint slides and video clips. This helps the presenters to develop research skills in their preparation, interpersonal skills in their group discussion and linguistic skills in public speaking. Role-play is an alternative way of presentation—student-tutors speak about a topic from the perspective of the imaginary person that they are portraying. For example, a student could assume the role of Albert Einstein when teaching a scientific concept, or speak as a parent when commenting on an educational policy. Role-playing is particularly helpful to student-tutors who are artistically or musically inclined as they are able to project the characters vividly. From my observation, role-playing is a popular and effective mode of presentation as it exposes the tutees to diverse and even opposing views, thereby challenging them to think deeply about the topic.

Class Activity

The presentation is followed by a class activity where the rest of the tutees participate in an activity led by the student-tutors with the aim to reinforce the lessons learnt and maximise class participation. Using a variety of student-centred activities, various types of multiple intelligences (especially bodily kinesthetic and interpersonal intelligence) are promoted. Below are some recommended class activities carried out by my student-tutors:

a) Small-group presentation

After dividing the tutees into smaller groups, each group is given a particular task that covers one aspect of the topic. Armed with writing materials and colourful markers, the tutees work on presenting their ideas in creative ways either through a 'show-and-tell' (where the groups take turns to present their ideas), or a 'gallery tour' (where students move from group to group to view the works of their peers). I observe that students are usually proud of their work and this brings out their team spirit as well as various types of intelligence, such as logical-mathematical (when they present a mathematical formula), musical (when they present a song), spatial (when they draw a map) and linguistic (when they present a poem).

b) Carousal

Tutees, as groups or individuals, go around the class to write down their comments on large sheets of writing paper posted at the four corners of the class. This will be followed by a time of class discussion where the student-tutors select certain comments (especially the controversial ones) and generate a lively class exchange.

c) Team-solo debate

Tutees are divided into the proposition and opposition teams and given time in their respective groups to discuss and generate as many ideas as possible to support their motion. This will be followed by a time of class debate where anyone could speak up for the team. An alternative is to number the students beforehand and those whose numbers are called have to speak on behalf of the team. The advantage of this modified form of debate is that the informal cooperative setting encourages students to be more vocal and participative. I find this method particularly useful for quiet students who need more encouragement to articulate their views with the support of their peers.

Peer tutoring is an effective way to help students learn actively and meaningfully as long as the professional teacher

continued on page 20...

The **Contract Game**

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Problem-based learning (PBL) is currently being emphasised in NUS teaching in order to have students apply what they learn in a practical situation. In the Faculty of Law, PBL has always been part of the teaching process. Students in the various law subjects are usually provided with hypotheticals (what other Faculties may refer to as case studies) as tutorial problems. They are then asked to analyse the factual situation, to discuss the rights of the various parties involved and to advise them.

PBL was taken one step further in the Law Faculty's Cross Faculty Module, "Introduction to Commercial Law", that covered contract law and company law. The problem with traditional PBL as used in most law schools is that the hypotheticals often seem distant and students find it hard to relate to the facts.

A new approach to teaching the module—the Contract Game—was introduced. The aim of this game was to get the students actively involved in making their own contracts and bearing the consequences of making poor contracts. Students were divided into teams and asked to negotiate with each other. The setting was the early 1800s when South East Asia was being colonised by the East India Company. Some of the teams were designated as ship-owning teams while other teams were cargo-owning teams. In order for the teams to make money, they would have to co-operate with each other so that cargo could be shipped to various parts of Asia. A small prize of Borders book vouchers was offered to the winning team. Teams would be judged on the profit they made as well as how well they learnt the lessons taught.

The evening lessons went on as normal, but usually ended slightly earlier to allow students to make contracts with each other. However, many teams did not need this extra time to deal with each other. Some teams commented that they got carried away with the game and were spending hours discussing deals first with their team-mates by handphone and the Internet, and then negotiating with other teams.

Apart from the main aim of teaching them skills in relation to contract law, students reported that they learnt a wide variety of skills from the exercise (e.g. teamwork and negotiation skills). They learnt how to read contracts carefully, how to draft them, and how to define terms and provide for unforeseen contingencies. The cargo owning and ship owning teams discovered that they could enter into a wide variety of arrangements. For example, some ship owners merely purchased cargo, some borrowed money from other teams in order to meet expenses, some entered into joint ventures with cargo owners with profits being shared in a variety of ways. To reward students who actively participated, one of the examination questions required them to either discuss what they had learnt from the Contract Game or to discuss its bad and good aspects.

The winning team won $90 worth of Borders vouchers donated by myself. They wrote an excellent report on why they deserved to win the game. Besides being the most profitable team, all its members also participated actively and played roles that showed a good division of labour in the team (e.g. one member in the team played the accountant to keep track of income and expenditure while another was in charge of market and competitor intelligence to keep track of what other teams were doing).

All in all, most of the students found the exercise extremely interesting and useful. However, a few commented that there were some downsides (e.g. some teams were not as active as the others, and some felt that the game dragged on for too long).

Suggestions and comments

Without wishing to sound as if I know how teaching in other law subjects and faculties can be best conducted, I would like to suggest how games could be used to teach a wide variety of subjects in the following ways:

- *Banking law*

  Some students could assume the role of bankers while others play the role of borrowers. The game could be carried out with a simple economic model attached so that bankers will have to juggle default protection against customer acquisition, while borrowers would like to provide as little collateral as possible.

- *Building and construction subjects*

  Students could be divided into teams representing the government planning authorities, developers, financiers and contractors.

- *Political science subjects*

  Students could be divided into teams representing different countries, with the power to make treaties with each other including free trade agreements, mutual defence treaties or even military co-operation treaties to attack a common enemy!

Gaming is a good way to teach because it tries to simulate a realistic environment where students can learn and practice their skills. Also, games suggest fun, while studies may imply tedium and boredom. Combining both helps to keep teaching exciting and lively.

However, gaming is not without its drawbacks from the teaching perspective. Gaming often puts students in direct

continued on page 9

Outcome–based Education (OBE): A New Paradigm for Learning

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In recent years greater attention is being paid to evaluate the outcomes of education to account for the returns of investments made in education (particularly public education). These increasing calls for accountability were a major reason for the rapid spread of various forms of outcome-based education in countries such as USA, UK and Australia during 1980 and 1990s. Likewise in Singapore, the recent development in the educational reforms towards knowledge economy and higher order economic efficiency call for quality and accountability in education. This article will elaborate on some issues involving OBE and teaching strategies to be taken while adopting OBE.

What is OBE?

OBE is a method of curriculum design and teaching that focuses on what students can actually do after they are taught. OBE addresses the key questions as:

a) What do you want the students to learn?

b) Why do you want them to learn it?

c) How can you best help students learn it?

d) How will you know what they have learnt?

Thus, the OBE's instructional planning process is a reverse of that associated with traditional educational planning. The desired outcome is selected first and the curriculum, instructional materials and assessments are created to support the intended outcome (Spady 1988; 1993). All curriculum and teaching decisions are made based on how best to facilitate the desired final outcome.

Towers (1996) listed four points to the OBE system that are necessary to make it work:

a) What the student is to learn must be clearly identified.

b) The student's progress is based on demonstrated achievement.

c) Multiple instructional and assessment strategies need to be available to meet the needs of each student.

d) Adequate time and assistance need to be provided so that each student can reach the maximum potential.

Why OBE?

The arguments developed by the proponents of OBE are:

a) OBE is able to measure—'what the students are capable of doing'—something which the traditional education system often fails to do. For example, assessment methods in a conventional education system often grade students based on their ability to choose a correct answer from a group of four or five possible answers. Such practices do not allow students to demonstrate what they have learnt. Ideally, students should have an understanding of the content, which is a cognitive skill that goes much deeper than finding the correct answer. OBE requires the students to understand the contents by "extending the meaning of competence far beyond that of narrow skills and the ability to execute structured tasks in a particular subject area and classroom" (Spady, 1995).

b) OBE goes beyond 'structured tasks' (e.g. memorisation) by demanding that students demonstrate his/her skills through more challenging tasks like writing project proposals and completing the projects, analysing case studies and giving case presentations etc. Such exercises require students to practise and demonstrate their ability to think, question, research, make decisions and give presentations. Thus, OBE involves students in a complete course of learning—from developing their skills in designing to completing a whole process (Spady, 1994a, 1995). OBE also identifies higher levels of thinking (e.g. creativity, ability to analyse and synthesise information, ability to plan and organise tasks). Such skills are emphasised especially when students are assigned to organise and work as a community or entrepreneurial service teams to propose solutions to problems and market their solutions.

The Four Basic Principles of OBE

a) Clarity of focus about outcomes[1]

- Always have the significant, culminating exit outcomes as the focus.
- Let the students know what they are aiming for.

b) Designing backwards

- Design curriculum backward by using the major

1. There could be two types of outcomes: major ones such as the exit outcome of the course and minor ones that are developed by the instructor for achieving the instructional goals.

continued next page...

outcomes as the focus and linking all planning, teaching and assessment decisions directly to these outcomes.

c) Consistent, high expectations of success

- Set the expectation that OBE is for ALL learners.
- Expect students to succeed by providing them encouragement to engage deeply with the issues they are learning and to achieve the high challenging standard set (Spady, 1994b).

d) Expanded opportunity

- Develop curriculum to give scope to every learner to learn in his/her own pace.
- Cater for individual needs and differences, for example, expansion of available time and resources so that all students succeed in reaching the exit outcomes.

Using Outcomes to Guide Instructional Planning

Instructional planning under OBE system takes four major steps:

a) Deciding on the outcomes

It is very important to define the outcomes of a programme in specific and precise manner. Spady & Marshall (1994) wrote:

> "Outcomes are clear, observable demonstrations of student learning that occur after a significant set of learning experiences... . Typically, these demonstrations, or performances, reflect three things: (1) what the student knows; (2) what the student can actually do with what he or she knows; and (3) the student's confidence and motivation in carrying out the demonstration. A well-defined outcome will have clearly defined content or concepts and be demonstrated through a well-defined process beginning with a directive or request such as 'explain,' 'organize,' or 'produce'."

Thus most outcomes and standards should be described in terms of three dimensions:

- CONTENT—simple to complex
- CONTEXT—simple to complex
- COMPETENCE—low to high

b) Demonstrating outcomes

Expected demonstrations will be defined by setting 'benchmarks' for each level of the programme. Each benchmark is a skill that must be demonstrated by the student. Unlike the outcomes, the list of benchmarks is different in every level of study. Benchmarks should address and define specifically the goals of the curriculum and determine ways to assess whether students have reached these goals at that level of study.

c) Deciding on contents and teaching strategies

One of the most common questions among teachers is 'what experiences will I need to provide?' At the beginning of any class the teachers will delineate expectations and outcomes to make the students feel like participants in classroom decisions. When this is done the students tend to be more supportive of activities and leaning processes taken in all aspects of the class.

There are two general approaches to implementing outcome-based models:

- 'Whole-class' models which seek to bring all learners in a classroom up to high levels of learning before proceeding further, and
- 'Flexible' models which use flexible grouping, continuous progress, technological approaches and instructional management.

The latter model requires the instructor to make a sincere attempt to meet each student at his/her level of competency and build upon the 'strengths already there' throughout the course. After the first few days of the course, students must have clearly understood the objectives of the programme. In addition, a classroom climate of mutual respect should have been built and the teacher has a great deal of information about each student. At this juncture, it would help if the instructor could conduct an assessment of students' mastery in varied areas, including the content they had learnt and other skills that they had developed. The assessment could help the instructor determine what instructional levels to begin the course at.

It is significant to note that a specific textbook is not used for these classes. Since a regular textbook would bring a sense of confinement, it is preferable to use a varied range of reference books and authentic materials from the world around. Each year, units of study are developed according to the changing needs of the student population and integrated into the curricula. In this manner one can build upon the interests of the students and individualise their classroom experience (Burns & Squires, 1987). Integral to this programme is the completion of projects, reports, and group activities to evaluate a student's thoughts and process of development. The projects are often open-ended, giving the students freedom to explore whatever their interests and abilities lead them to.

d) Assessments in OBE

The entire curriculum in OBE is driven by assessments that focus on well-defined learning outcomes and not primarily by factors such as what is taught, how long the student takes to achieve the outcomes or which path the student takes to achieve their target. The learning outcomes are set out on a gradation of increasing complexity that students are expected to master these outcomes sequentially. Willis & Kissane (1995) suggested two techniques for assessing students' learning outcomes:

- 'Standard-referenced assessment' (similar to criterion-referenced assessment but with a clearer description of expected performance), and
- Student portfolios documenting their progress.

continued next page...

Outcome–based Education (OBE): A New Paradigm for Learning

...continued from page 8

Given that assessments in OBE focus on the students' learning outcomes (i.e. how much and how well the students have learnt), this could imply that students with different abilities will follow different paths to reach their goals and may finish at different times. This brings forth some questions on when and how often to carry out the assessments in a semester or how many attempts should a particular student be allowed to show her/his abilities.

In addition, as OBE requires ongoing feedback between the student and the lecturer, continuous assessments could help the lecturers determine the following:

- How to achieve the learning outcomes?
- What is the progress of particular students in the class?
- When to assess the students on how much they have learnt?

Conclusion

OBE promises high level of learning for ALL students as it facilitates the achievement of the outcomes, characterised by its appropriateness to each learner's development level and active and experienced-based learning. Moreover, knowing that this system is going to be used would also give students the freedom to study the content of the course in a way that helps them learn it. OBE must involve administrators, educators, parents, teachers and students for successful implementation.

References

Burns, R. & Squires, D. (1987). *Curriculum Organization in Outcome-Based Education*. San Francisco: Far West Lab for Educational Research & Development.

Spady, W. (1988). 'Organizing for Results: The Basis of Authentic Restructuring and Reform'. *Educational Leadership*. Vol. 46, No. 2 pp. 4–8.

Spady, W. (1993). *Outcome-based Education*. Belconnen, ACT: Australian Curriculum Studies Association.

Spady, W. (1994a). 'Choosing Outcomes of Significance'. *Educational Leadership*. Vol. 51, No. 6, pp. 18–22.

Spady, W. (1994b). *Outcome-based Education: Critical Issues and Answers*. Arlington, VA: American Association of School Administrators.

Spady, W. and Marshall, K. (1994). 'Light, not Heat, on OBE'. *The American School Board Journal*. Vol. 181, pp. 29–33.

Spady, W. (1995). 'We Need More 'Educentric' Standards'. *Educational Leadership*. Vol. 53, No. 1, pp. 82–84.

Towers, J.M. (1996). 'An Elementary School Principal's Experience with Implementing an Outcome-based Curriculum'. *Catalyst for Change*. Vol. 25, pp. 19–23.

Willis, S. and Kissane, B. (1995). *Systemic Approaches to Articulating and Monitoring Expected Student Outcomes*. Murdoch, Western Australia: Murdoch University. ■

Motivating Students in a Writing Class

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Hamm, Mary & Adams, D. (1992). *The Collaborative Dimensions of Learning*. Norwood, NJ: Ablex Publishing Corp.

Hewitt, G. (1995). *A Portfolio Primer: Teaching, Collecting, and Assessing Student Writing*. Portsmouth, NH: Heinemann.

International Conference on Computer-assisted Instruction (ICCAI) 95 Article. 'The Mechanisms of Collaborative Learning'. http://tecfa.unige.ch/tecfa/research/CMC/colla/iccai95_5.html. (Last accessed: 8 May 2003).

Johnson, David W.; Johnson, Roger T. & Holubec, Edythe W. (1994). *Cooperative Learning in the Classroom*. Alexandria, VA: Association for Supervision and Curriculum Development (ASDCD).

Kagan, Spencer. (1992). *Cooperative Learning: Resources for Teachers*. Capistrano, CA: Kagan Cooperative Learning.

Michaelsen, Larry K.; Black Robert H. & Fink, L. Dee. 'Problems with Learning Groups: An Ounce of Prevention …" Adapted from Michaelsen, L.K.; Black, R.H. & Fink, L.D. (1996). 'What Every Faculty Developer Needs to Know about Learning Groups'. In *To Improve the Academy: Sources for Faculty, Instructional and Organizational Development, 1996*. Richlin, L. (ed.). Stillwater, OK: New Forums Press Co.

Middle English. (2002). 'Portfolio Writing in Composition Courses'. The On-going Interactive Newsletter of the English Department, Middle Tennesee State University. http://www.middleenglish.org/MiddleEnglish/portfolio.htm. (Last accessed: 8 May 2003).

Millis, Barbara J. (May 1996). 'Cooperative Learning'. Presented at The University of Tennessee at Chattanooga Instructional Excellence Retreat. http://www.utc.edu/Teaching-Resource-Center/CoopLear.html. (Last accessed: 8 May 2003).

Tierney, R.J.; Carter, M. & Desai, L. (1991). *Portfolio Assessment in the Reading-writing Classroom*. Norwood, MA: Christopher Gordon. ■

The Contract Game

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competition with each other (i.e. interaction is required). Bitter feelings can sometimes be generated when students feel that others have not played fair or have deceived them. Running a game also requires a substantial amount of work in designing the game and administering it (feeding information to the students, recording their actions, and keeping track of the game situation). It is often not possible to introduce gaming situations strictly at the same pace as the subject is taught. Thus students may have to deal with problems for which they have not been taught the solution. Some students may be unhappy with such a situation. Finally, in games, random events, which may affect different teams in different ways, are often introduced. For example, if storms occur, some teams might lose their ships. Students may claim that this is not fair, but "Welcome to the real world!" would be my reply. Bearing this possible inequality in mind, lecturers should consider how performance during gaming would affect the students' final grade for the subject.

Please send comments and criticisms on the article to the author at: *lawtanbc@nus.edu.sg*. ■

CDTL Survey on Educational Resources and Faculty Needs

The Centre for Development of Teaching and Learning (CDTL) conducted an online survey on educational resources and faculty needs from 1 July–10 August 2003. The main objectives of the exercise were:

- To understand the academic staff's level of interest in teaching materials/resources
- To discover whether the academic staff have knowledge of the various facilities and teaching materials available at CDTL and how frequently the staff access teaching materials/resources at the Centre
- To know about other educational resources that can support the academic staff in their teaching

In total, we received 309 responses (approximately 15% of the NUS teaching staff). The following are some findings and suggestions compiled from the survey:

1. **Publicity:** The CDTL Resource library and its online facility need more advertising and publicity.
2. **CDTL publications:** Academic staff considered CDTL newsletters and books as one of the main resources when looking for teaching related resources/materials.
3. **A prominent link:** There were suggestions to post a clear and prominent link to the CDTL Library on the home page of the NUS Libraries.
4. **Online information:** Recommendations were made to provide the following information on a regular basis:
   - Monthly e-Reviews of books/resources
   - Monthly highlights of specific books, chapters or papers that focus on practical aspects of teaching/ specialised areas of teaching
   - Monthly recommendations of good reading materials
5. **Access to resources for obtaining materials/resources related to teaching:** There were suggestions to provide the academic staff with the following facilities:
   - Discipline specific resources
   - Listserv subscriptions (e.g. Stanford Learning Lab, Tomorrow's Professor)
   - Online resource materials for adapted books
   - Scientific databases
   - Printed education journals and newsletters
   - Field specific educational textbooks, teaching-aids and websites
   - Publisher websites
   - Peer-reviewed journals and journal paper samples
   - CDTL Digital library
6. **Recommend titles:** Allow academic staff to recommend the purchase of educational journals, books and materials.
7. **Drop-off points:** Books borrowed from the CDTL Library can be returned at designated drop-off points around the campus.
8. **Multimedia teaching aids:** There were proposals for the acquisition of the following resources:
   - Acquire videos/CDs on the teaching of specific topics
   - Post video recordings of past CDTL seminars/ workshops online for those who cannot attend the actual sessions
   - Field specific teaching aids like PowerPoint slides, images, short videos and audio conversations ■

CDTL Monograph Series

CDTL has a series of monographs done by former CDTL staff. Faculty members can view the monographs at https://online.nus.edu.sg/cdtl/staff/monograph.htm (access restricted to NUS faculty & staff).

Hard copies of the monographs are also available for browsing at the **CDTL library**:

Chee Yam San. (2000). *NUSCast Survey: Instructor Perspective.*

William Koh. (2000). *Executive Summary of the Employers' Survey*.

C.M. Wang, Chandrama Acharya & Glen O'Grady. (2001). *Construction and Evaluation of Teaching Portfolio.*

Chandrama Acharya. (2003). *NUSCast Survey: Student Perspective.* ■

Calling All Writers...

CDTL invites articles on any teaching and learning topic for the following two newsletters:

- **CDTLink** (700 words maximum per article; photos & illustrations in hard/digital copy are welcomed)
- **CDTL Brief** (text-only newsletter; 1000 words maximum per article)

To submit articles for consideration or to obtain more informartion, please contact: **Ms Teo Siok Tuan**

Email: sioktuan@nus.edu.sg

Tel: (65)-6874 8047 • Fax: (65)-6777 0342 ■

Call for Registration

TLHE 2004

International Conference on Teaching and Learning in Higher Education

1–3 December 2004

*Theme: **Individual** and **Institutional Self-assessment** in **Higher Education***

CDTL will be conducting its third conference on Teaching and Learning in Higher Education. The conference aims to examine the problems of self-assessment from the points of view of both teachers and institutions. The conference will also cover related topics such as:

- Facilitating Independent Inquiry and Understanding Modes of Inquiry
- Constructivist Learning
- Evidence Based Knowledge
- Critical Thinking
- Enhancing Creativity
- Facilitating Interconnectivity
- Student Assessment
- Teacher Appraisal and Teacher Education
- Active/Interactive Learning
- Problem-based Learning and Inquiry-based Learning
- Project-based Learning and Case-study Based Learning
- e-Learning and Distance Learning

A pre-symposium workshop will be conducted on 30 November 2004.

Keynote Speakers

Peggy Maki, *Senior Scholar, American Association for Higher Education.*

Brenda Smith, *Learning Teaching Support Network Generic Centre, United Kingdom*

Invited Speakers

Caroline Baillie, *Queens University, Canada*

Jean Michel, *Ecole Nationale des Ponts et Chauss, France*

Joan Collinge, *Simon Fraser University, Canada*

Lynne Baldwin, *Brunel University, Uxbridge, United Kingdom*

Michael Wald, *Dublin Institute of Technology, Ireland*

Ora Kwo, *The University of Hong Kong, Hong Kong*

Peck Cho, *Michigan Technological University*

Registration

Registration for the conference is S$500 if payment is made on or before 1 October 2004 and S$550 if payment is made after this date. The fee will cover a copy of the conference proceedings, admission to all sessions, conference banquet, lunches and refreshments.

For more information and/or to register online, please refer to *http://www.cdtl.nus.edu.sg/tlhe/default.htm* or contact:

Ms Rita Roop
Centre for Development of Teaching & Learning
National University of Singapore
10 Kent Ridge Crescent, Singapore 119260
Email: *cdtrrk@nus.edu.sg*
Tel: 65-6874 2071 Fax: 65-6777 0342 ■

Welcome!

CDTL would like to welcome as Affiliates the following:

- A/Prof Helmer Aslaksen (*Department of Mathematics, Faculty of Science*)
- Ms Ng Boon Yuen (*Department of Information Systems, School of Computing*)
- A/Prof Tan Cheng Han (*Faculty of Law*)
- A/Prof Voon Chee Tet, Francis (*Department of Anatomy, Faculty of Medicine*)
- Prof Wang Chien Ming (*Department of Civil Engineering, Faculty of Engineering*)
- Dr Grace Wong Khei Mie (*Department of Real Estate, School of Design & Environment*)
- A/Prof John Whalen-Bridge (*Department of English Language & Literature, Faculty of Arts & Social Sciences*)

Goodbye!

We would also like to thank:
Miss Verena Tay, Publications Officer who left at August 2003 for all her invaluable support in the past and wish her well for her future endeavours. ■

TEACHING & LEARNING highlights

Faculty of Arts & Social Sciences

Geography Department's Field Studies Module Offers Students Fresh Perspectives of the World

NUS students learning about forest plants and their uses from a community forest practitioner in Tamot, southern Thailand, December 2002.

The Geography Department's Field Studies module is both a conventional university course and something very different. It involves several seminars before the overseas component. These seminars focus on practical fieldwork issues, methodologies, research ethics, an introduction to the places to be visited and health & safety matters. The actual period of field studies is five weeks. The next round will be based in Chiang Rai Province, northern Thailand from 14 June to 20 July 2004. Upon return 'from the field' students work on an individual field report for submission and assessment.

During the field studies overseas, students work in small teams on specific projects that range from physical and environmental themes to social and cultural geographies. Much of what the students learn is purely and properly academic. They apply different techniques of gathering primary data, which they must later analyse and synthesise. However, there is also another element to the learning process. Many of the activities involve cooperation and collaboration, not only among students and professors, but also with their hosts abroad—student buddies, scholars, various non-academic practitioners and local communities. Thus, Field Studies is as much about getting to know and appreciate different cultures and 'ways of living' as it is a challenging academic module. It is clear from the video made about the last Field Studies in Pattani, Songkhla (southern Thailand) and Penang (Malaysia) that the module delivers more than information and concepts—it changes ways of thinking about the world. ■

Faculty of Medicine

OSCE in Medical Assessments

The Objective Structured Clinical Examination (OSCE), a measure of clinical competence that focuses on outcomes via observable behaviours, is gaining recognition. First introduced in 1975, it is a way of measuring clinical competence that allows for control of many of the biases of conventional methods. The evidence to date suggests that with appropriate attention to design, the OSCE is a reliable test with good validity.

The Faculty of Medicine has been using OSCE as a measure of skills competencies at the end of Year 2 in the Clinical Skills Foundation Course (CSFC) and is considering extending the use of OSCE as a component of the clinical examination in the Final MBBS Professional Examination. The objective of this proposed OSCE is to assess Final Year medical students in the medicine and surgery tracks, on their level of clinical competence and communication skills. Generally, competencies in following tasks/skills will be conducted:

- History taking
- Physical examination
- Procedures
- Data interpretation
- Patient management
- Communication and Patient Education

In principle, this method of assessment is an extension of the clinical training environment that the students were trained in. Thus, they should be familiar with it as part of clinical practice. The OSCE would help assess a comprehensive set of integrated core skills and practice knowledge in the medicine and surgery tracks. ■

Faculty of Engineering

Using Narrative Strategies to Enhance Teaching of Engineering Modules

To help students learn effectively, teachers must continuously innovate new ways of teaching to engage the students meaningfully. For Engineering modules that are not predominantly mathematical, the following teaching methods may be used:

- Integrating fundamental knowledge with real life events that has received tremendous media attention,

- Linking fundamental knowledge/concepts with stories, and
- Highlighting breakthroughs in research/innovations that have made a significant impact on mankind.

The above-mentioned approaches were used in an Engineering module, MST 5006/ME5506 "Corrosion of Materials" with a class size of 196 postgraduate students. One of the examples used was a recent real life incident of how a corroded lamp post fell, struck the head of a 13-year-old boy and caused his death (see *The Straits Times*, 4 March 2003, 'Fallen Lamp Post was Checked 3 Days Before'). In addition, the emergence of new award winning industrial products to combat corrosion was highlighted to the class. To inculcate the spirit of teamwork, students were divided into small discussion groups during the lecture to analyse the factors that caused the lamp post to collapse. Students were then asked to deliberate on their interpretations, which were simultaneously refined to arrive at the best possible logical solution. The main emphasis of conducting such exercises during the lecture was to highlight to the students that a firm grip on fundamentals may enable them to overcome such engineering failures/tragedies.

The effectiveness of such teaching methods was confirmed through the students' feedback at the end of the module. Part time students from industry were so thrilled that they wanted to train their colleagues in a similar area using the same style of teaching. Yet another student used the knowledge gained from this module to select the best material for replacing his house gate. The interior decorators' advertisement message, 'There is Always Room for Innovation' applies to education too. ■

Faculty of Science

Course on Current Trends, Innovation & Entrepreneurship in Biology

Mr Anwar Jumabhoy, a business consultant based in Kuala Lumpur, talks to students about writing biotechnology business proposals

Students from Faculties of Science, Medicine and Engineering, Division of Bioengineering, Bioinformatics Institute and NUS-integrative Graduate School attending the course

Current advances in modern life sciences and biotechnology have not only propelled scientists to form multidisciplinary teams but also to innovate and commercialise research outcomes at unprecedented rates. The Department of Biological Sciences has been responding to the existing swing in modern life sciences, by evolving and mounting courses that expose students to the 'real world' situations in innovation and commercialisation in biotechnology. Recently, the Department organised a course on current trends, innovation and entrepreneurship in biology. The profiles of guest speakers included technopreneurs, biotechnology-based business consultants, venture capitalists, patent attorneys and industry liaison experts from NUS. During the course, students formed teams and learnt how to write and defend their business plans based on talks and outlines given by the various speakers. Students from Faculties of Science, Medicine and Engineering, Division of Bioengineering and Bioinformatics Institute have taken the course. ■

Setting up an Environment for Independent Thinking

The module, LSM 5201 "Structural Biology and Proteomics" focuses on recent advances in topics related to structural biology and proteomics. It discusses various fundamental technologies that are used in the determination of protein and nucleic acid structure, protein folding, structure-function relationships of proteins, proteomics and functional genomics. Most of the lectures are conducted in an informal environment where students have a lot of opportunities to openly ask the lecturer how to tackle a specific problem and other problems related to the students' research. The casual environment also applies to lectures given by in-house experts on their area of specialisation as well as guest lectures by distinguished visiting scientists from abroad, NUS and other Research Institutes in Singapore. Such open and informal setting makes the course attractive to many graduate students.

Besides attending lectures, students are required to participate actively in the form of presentations/discussion and analyse recent research articles in the area. For oral presentation, the students may choose research papers in one of the four major areas covered in the module: Structure Determination; Structure-function Relationships; Protein Folding and Engineering; or Proteomics and Functional Genomics. Each student will then select a second paper for critical analysis from the remaining three fields. The oral presentation and critical analysis would need the students to learn how to critically read and evaluate the techniques, results and conclusions of the paper. Such arrangements help the students think independently and develop skills in the area of Structural Biology and Proteomics. ■

Teaching Mathematics and Training Mathematicians

Professor S L Lee
Head, Department of Mathematics

Introduction

Teaching mathematics and training mathematicians are two fundamental responsibilities of a Mathematics Department. The problem of determining what to teach, how to teach and how much mathematics to teach to students is not a mathematical problem with a unique solution. It is a controversial issue, in which many mathematicians, scientists and engineers do not agree with one another. Different people hold different views and different expectations of mathematics. Although the aim of teaching mathematics in general may be different from that of training mathematicians, the two activities have an overlapping set of objectives. I will:

- Present some of the problems we encounter in our attempts to train mathematics graduates through rigorous mathematics education;
- Illustrate the difficulties for pure mathematics to reach out to science and engineering; and
- Discuss the steps taken by the Department to address these problems.

The Controversy in Teaching Mathematics

Many mathematicians who are consciously or unconsciously influenced by the Bourbaki[1] philosophy and tradition share the view that all mathematics students must see the proof of every theorem at least once in their life. Although the "axiom-theorem-proof" style in teaching mathematics has been a popular approach in the training of mathematicians, the Russians hold a contrasting view. The following excerpt from the article by Arnold V.I.[2], *On Teaching of Mathematics*, delivered in Palais de la Découverte, Paris, March 1997, sums up the Russian school of thought:

> "When I was a first-year student at the Faculty of Mechanics and Mathematics of the Moscow State University, the lectures on calculus were read by the set-theoretic topologist L.A. Tumarkin, who conscientiously retold the old classical calculus course of French type... . These facts capture the imagination so much that (even given without any proofs) they give a better and more correct idea of modern mathematics than whole volumes of the Bourbaki treatise."

The teaching of mathematics to physics and engineering students is even more controversial. Some engineers believe that engineering students should be taught mathematics the way mathematics students are taught. This actually happens in top US universities, like MIT and Cornell, all French Grand Écoles, top French universities and most Russian institutes of higher learning. Partly a result of practical considerations, many physicists and engineers however, do not agree with this philosophy. They are of the view that their students need to learn advanced mathematical methods and concepts such as Fourier transforms, partial differential equations, operators and Hilbert spaces as early as possible. Mathematicians often describe such mathematics syllabuses as unrealistic, too ambitious and impossible to teach effectively. This problem is encountered in many universities and very much so in NUS.

Many scientists, engineers and mathematicians believe that a better understanding of physical laws can be achieved through a proper understanding of the underlying mathematical principles. Likewise, many mathematicians also believe that mathematics students should know enough science, engineering or economics to which they can relate their mathematical knowledge. However, mathematical knowledge is so diverse that not all can be related to the physical world[3].

Pure Mathematics, Applied Mathematics or Mathematics

Is there a characteristic distinction between pure and applied mathematics? Many scientists and mathematicians are of the opinion that there is none. Some even maintain that there is no such thing as pure mathematics or applied

1. Bourbaki, N. is a group of mostly French mathematicians, which was formed in the 1930s with the aim of writing a thorough unified account of all mathematics from a single source of axioms. The stated purpose of its treatise is to provide a rigorous foundation for the whole body of modern mathematics. Bourbaki had tremendous influence on the way mathematics has been taught, not only in France, but also in Europe and the US.
2. Arnold, V.I. is a prominent Russian mathematician who holds a joint appointment at the Steklov Mathematical Institute in Moscow, Russia and the Université Paris 9 in France. He is the winner of the 2001 Wolf Prize (a mathematical award equivalent to the Nobel Prize), in recognition of his achievements in mathematics.
3. This reminds me of the following remark by a French mathematician in response to a question from the audience during a talk he delivered in the early seventies, "I am a pure mathematician, and I don't care how the mathematics is used." Even now I can remember vividly that being charismatic, confident and flamboyant, he gave an excellent and impressive lecture. That was how young mathematical enthusiasts were won.

mathematics. There are only mathematics and applications of mathematics. My personal view is different. For all intents and purposes, the distinction between pure and applied mathematics has become a reality, although there is no boundary separating them. There are differences in philosophy, in culture and values that distinguish a pure mathematician from an applied mathematician. Let me illustrate this view with anecdotes and examples.

Pure mathematics is a perfect game in mountaineering according to Arnold V.I. (1995):

> "At the beginning of this century…the value of a mathematical achievement is determined, not by its significance and usefulness as in other sciences, but by its difficulty alone, as in mountaineering. This principle quickly led mathematicians to break from physics and separate from all other sciences."

Arnold appears to be very unforgiving about this trend and blames mainly Hilbert for what he calls the self-destructive advancement of mathematics. However, I believe that if democracy survives, (which I hope it will), then this trend will continue and intellectual competition will go on, and this is only half of the aim of an enterprise that I call pure mathematics. I personally believe also that the ability to divorce from the physical world into a world of imagination is one of the strengths of mathematics. We should let the mind wander where it can reach. The downside is that, whereas in real mountaineering all players know exactly where are the challenging peaks to climb, in mathematical mountaineering the peaks are often created by leading groups of mathematicians.

Because they are judged purely on their intellectual strength, pure mathematicians strive for perfection. Pure mathematics becomes a perfect game. Results without rigorous proofs are not acceptable, gaps and holes, no matter how tiny they are, are not tolerated. Results without conditions are considered to the best. Anything short of necessary and sufficient condition is usually not appreciated.

The other half of pure mathematics enterprise is to increase the body of knowledge by developing theories without necessarily considering its practical consequences. However, sometimes it can spring surprises, when mathematicians, scientists or engineers twig results in pure mathematics and shape them to fit the imperfect world. For instance, prime power factorisation of integers, which is an activity in number theory, is the principle behind cryptography and computer security. This is an example of an activity in applied mathematics.

It is impossible to define mathematics, pure mathematics or applied mathematics. There are no clear boundaries separating applied mathematics from science, engineering and economics as there is no clear boundary separating applied mathematics from pure mathematics. Like pure mathematics, applied mathematics is also an enterprise that strives to increase the body of knowledge, except that the knowledge is perceived to be relevant to science, technology or economics.

Mathematics that can impact and create breakthroughs in science and technology are very often not sophisticated mathematics. An example is the **Rivest-Shamir-Adleman (RSA) Cryptosystem,** which has enormous impact on the secure exchange of information. However, the underlying mathematics was not deep, not difficult and not new. To understand why it was a breakthrough, we need to know the problem it solved and the state-of-art then (Tay, Y.C. 2001).

I would envisage an applied mathematician as one with multidisciplinary background and wide knowledge in mathematics as well as in science, engineering or economics. Here are some examples to illustrate my point.

Nobert Wiener was the father of Cybernetics, the mathematical study of control and communication in the animal and machine. Though his works that are permanently displayed along the Infinite Corridor at the MIT exhibit ingenuity and richness of ideas, they are not highly regarded by pure mathematicians.

John Tukey was well known for his work with Cooley on the Fast Fourier Transform (FFT), which revolutionised the world of digital image processing. FFT is extremely simple with no sophisticated mathematical ramifications.

C.E. Shannon was an engineer as well as a mathematician whose greatest contribution to knowledge was his mathematical theory of communication, which is a simple mathematical problem (on hindsight) in sampling and interpolation. Slepian (1974) wrote:

> "Probably no single work in this century has more profoundly altered man's understanding of communication than C E Shannon's article, 'A mathematical theory of communication'…."

Is Mathematics Unnatural to Ordinary Man?

I believe that if mathematics is divorced from reality and taught in a rigorous axiom-theorem-proof tradition in lectures, there is a danger that most students will find it unnatural. The rebellious ones will reject it while the law-abiding ones will force themselves into a habit of drilling to conform to the way things are usually done without real understanding. Only a few students who have the mathematical aptitude will benefit from such a treatment.

Moreover, the mathematics that we teach from textbooks has been beautifully refined over the years. Very often, a good lecturer would give beautiful and elegant lectures, without referring to any notes. This is of course very impressive to students, but it can also create a wrong perception about studying mathematics. Students who have gone through such a teaching environment in all their courses may not be very different from children who are brought up in rich and sheltered environments.

In learning mathematics, I believe that most students would enjoy learning if they can acquire the general understanding of the ideas and principles in the beginning. Those exceptional ones who yearn for deeper understanding, for

continued on page 18...

Writing Educational (Learning) Objectives to Facilitate Student Learning

Professor Matthew C.E. Gwee
Department of Pharmacology & Medical Education Unit
Associate Director CDTL

Associate Professor Tan Chay Hoon,
Department of Pharmacology & Medical Education Unit

> "Learning objectives…assist the teacher in designing instructional systems by guiding the selection and sequencing of subject matter content and the choice of instructional material and procedures. …**enable a student to guide and manage his own learning**. …serve as criteria for assessing student achievement and for evaluating the quality of instruction." (Davis, *et al*., 1974)

Classification: Knowing Doing and Feeling Domains

Educational (learning) objectives are clearly written statements or descriptions documenting a teacher's intent and expectations of the educational outcomes, including the expected level of performance to be achieved after a period of learning. Essentially, educational objectives convey in a meaningful way what the teacher expects students, after completing a course of study, to *know*, be able to *do* and be able to *feel* (i.e. to be able to display an appropriate response, in terms of attitudes and behaviour, in a given situation). In general, educational objectives are often classified within three learning domains (categories):

- *Cognitive* (*knowing*) domain: focusing on knowledge and information acquisition, retention and recall, and higher order thinking and intellectual skills and ability;
- *Psychomotor* (*doing*) domain: relating to skills that require various levels of well co-ordinated physical activity and manipulation, such as in speech making, the performing arts, operating machinery, surgical procedures; and
- *Affective* (*feeling*) domain: dealing with feelings, emotions, mindsets and values, including the nurturing of desirable attitudes for personal and for professional development.

Formulation Of Educational Objectives

Whether or not educational objectives in all three learning domains need to be formulated for a given course of study will depend upon the intended learning outcomes. For example, the educational objectives for a lecture will usually focus mainly on the cognitive domain. However, educational objectives in all three learning domains will be required in a medical or some other professional course in which it is also important to nurture the students' communication and interpersonal skills for future professional practice. It is also not necessary to have equal proportions of educational objectives for every learning domain, as the distribution will be determined by the intended learning outcomes in each domain.

In addition, in formulating educational objections, it is best to use words or phrases (e.g. to identify, to differentiate, to evaluate, to perform a particular task or procedure, to elicit a response from) that describe, as precisely as possible, *measurable* or *observable learning outcomes*. Phrases like 'to know', 'to understand', and 'to appreciate', which are not precise enough for this purpose, may however be used in statements that describe the *general goals* of a course/programme. The educational objectives could also specify the performance level expected of the students under a given set of conditions.

For example, the intended outcomes of this article can be conveyed to readers in the form of educational objectives as shown in Figure 1 on page 19.

Although teachers and students can benefit from well-formulated educational objectives, there can be some limitations. Educational objectives can be difficult to formulate for the affective domain and are generally more useful in disciplines that have a high sequential content structure. Furthermore, it is not possible to identify all potential educational outcomes of learning at the beginning of a course, and specific educational objectives tend to make learning/education too mechanistic.

Enhancing Achievement Of Learning Outcomes

Educational objectives will enhance achievement of the

continued on page 19...

Collaborative Learning Online: Setting the Stage

Mr Paul Gagnon
Department of Educational & Staff Development
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As online learning continues to gain acceptance among instructors at tertiary institutions (McGraw-Hill Ryerson, 2003), of necessity, lecturers will begin to explore the Group Learning Environment (GLE) that is built into the Learning Management System (LMS) used in their respective institutions. Such explorations will build on the successful *morphing* of effective face-to-face (FTF) collaborative learning processes to the GLE. To address some of the inchoate challenges inherent in such *morphing*, this paper models a three-stage Socratic approach. Each stage addresses a question posed from a student perspective and then provides a brief rationale and, where appropriate, an example designed to *spark* subsequent adaptive responses on the part of the reader.

Stage One: How am I supposed to do this?

To achieve success at this stage begin by focusing on *skills development*. An institution's LMS will probably enable instructors to create and enrol groups, as well as assign to each group, various communication tools such as a Discussion Forum, a Whiteboard, a Virtual Chat, and Group Email. It needs to be stressed, however, that simply creating a group, enrolling members, providing access and assigning students a project will not ensure proper usage or success. Students will resist and question the benefits of such activities (Eijl & Pilot, 2003). To obviate some of this resistance, train the students to use the tools. For example, instead of simply announcing that a group discussion tool is available to the students, instructors could spend some time helping the students develop their *skills* with the tool. One approach could be an icebreaker exercise. First, create a discussion forum in which you could ask the students to introduce themselves to each other, using the following questions as a guide:

- What Primary school did you attend?
- What is your favourite childhood memory?
- Who was your childhood hero and why?
- What three adjectives would you use to describe yourself?
- What three adjectives would your friends use to describe you?

Answering these questions not only enables the students to familiarise themselves with the tools in a non-threatening way, it also provides the first step towards building group cohesiveness and an online community. Similarly, if instructors want the students to use the Whiteboard to create a workflow chart, or to brainstorm solutions to problems, spend some time practising using the tool with the class informally, before splitting them into smaller groups.

Stage Two: What am I supposed to do?

Whether the instructor is of the *sage on stage* or *guide on the side* interventionist mindset (Mazzolini & Maddison, 2002), providing students with some structure is essential to helping them succeed in their assigned task/s. Here is a sample approach for instructors to consider:

1. Create small groups of twos or threes, as larger groups tend to spend more time organising than attending to tasks. (Eijl & Pilot, 2003).
2. Make available to each group a document which outlines clearly:
   - the nature of the task,
   - the instructors' expectations regarding each member's participation,
   - a suggested process for working through the project,
   - how the instructor will contribute, and
   - how the group will be monitored.
3. Within each group's work area create a number of discussion forums to serve as a record of their progress and processes, and insist that each group member participates.
   - *Forum 1: Group Responsibilities*

     Stipulate that each group member outlines his/her responsibilities within the group.
   - *Forum 2: Work Schedule*

     Require that each group member report regularly (e.g. weekly, in five sentences or less) his/her progress on the project, plus any other anecdotal comments related to his/her work in the project.
   - *Forum 3: Pedagogical Guide*

     Provide a series of guiding questions to which the groups must refer and respond when they encounter problems along the way. In addition, make it compulsory for each member to respond at least once during the project. Here are some examples which require the students to explain:
     - the nature of the problem,
     - how the problem was communicated to the rest of the group,

continued on page 19...

Teaching Mathematics and Training Mathematicians

...continued from page 15

details and rigour are the ones who have the traits of a mathematician and they can be given special attention like what the Department has done in its programme to nurture special mathematics talents.

It is obvious that no one approach in teaching will be effective for all students. I prefer a curriculum that has a few paths to cater to students with different habits and abilities in learning.

A Way Forward

The Department of Mathematics is a relatively large department with expertise in pure as well as applied mathematics. Traditionally, it is strong in pure mathematics, and has established its strengths in a number of areas, including representation of Lie groups, topology and geometry, logic and set theory, probability, algebra and number theory. To increase the international visibility of the Department as a whole, we will continue to strengthen the traditional areas of mathematics. At the same time, we are building up new emerging strategic areas that are driven by the development of modern science, technology and economics. These new emerging strategic areas will form an outer core of the Department to engage in multidisciplinary activities in mathematics with science, engineering, economics and finance. This outer core will be a bridge for the Department of Mathematics to reach out to the other departments within the university, as well as research institutes and the industry.

These emerging strategic areas are organised into two overlapping research groups: Coding Theory & Information Security and Computational Biology, and three faculty-based centres:

- Centre for Wavelets, Approximation and Information Processing (CWAIP), which has already established an international reputation in its research in wavelets and their applications to information processing;
- Centre for Industrial Mathematics (CIM), which focuses on scientific computing, optimisation and industrial aspects of information security;
- Centre for Financial Engineering (CFE), which will be developed into a self-funded centre to lead in multidisciplinary activities combining both theory in financial mathematics and practice in financial engineering.

The CWAIP, CIM, CFE together with the two strategic research groups of Coding Theory & Information Security and Computational Biology will form the outer core of the Department of Mathematics. They will develop capabilities and mathematical resources to engage in multidisciplinary activities in teaching, research and development in areas such as high performance computing, biomedical sciences, information processing, security & communications, and quantitative finance.

These capabilities and resources will also be extremely useful in particular to the teaching of mathematics to non-mathematics majors, an activity that is important to Mathematics. It would be a paradigm shift in the philosophy of service mathematics teaching, which would not only benefit the students, but also help to foster multidisciplinary activities within the University, thus providing opportunities to students and staff to have a wider and better understanding of applications of mathematics and its relations with other subjects.

References

Arnold, V.I. 'On Teaching of Mathematics'. An extended text of the address at the discussion on teaching of mathematics in Palais de Découverte in Paris on 7 March 1997 is available at http://pauli.uni-muenster.de/~munsteg/arnold.html. (Last accessed: 22 April 2003).

Arnold, V.I. (1995). 'Will Mathematics Survive?' *The Mathematical Intelligencer.* Vol. 17, No. 3, pp. 6–10.

Slepian, D. (ed.). (1974). *Key Papers in the Development of Information Theory.* New York: IEEE Press.

Tay, Y.C. (2001). 'Understanding, Assessing and Rewarding Multidisciplinary Research and Industrial Applications.' Report prepared for the Department of Mathematics. ■

A Vision for Effective Teaching

...continued from page 2.

Love and concern must be combined with professionalism in communication or the students will take the teacher for granted. The start and end of lessons must be planned and suitable practical examples must be discussed. Topics should proceed from concrete to abstract, must be properly interlinked, and should keep the student challenged. When combined with the ingredient of loving concern for student welfare, the whole experience is very sweet and dynamic.

Summary

Some foundational principles of effective teaching are discussed. Mere development of recipe book-type teaching skills is like beating the chaff after rice grains have been removed; it is neither likely to sustain students' interest, nor enjoyable for the teacher. A teacher who masters the foundational principles will have a challenging and adventurous career. Universities wanting teaching excellence should realise that working on such a grassroots level demands significant investment of time and resources from its faculty members. However, it will yield excellent long-term 'products'—dedicated students with a drive for education. ■

Collaborative Learning Online: Setting the Stage

...continued from page 17

- whether the group felt the problem was resolved, and
- how the group might have avoided the problem.

Stage Three: How am I to be assessed?

A crucial aspect of student acceptance of any collaborative process is that for all the activities in which the students participate, there is an assessment value that is tied directly to the overall course assessment (Macdonald, 2003). For example, in Stages One and Two, there should be specific assigned activities, each having an assessment component with increasingly demanding assessment criteria that reflect both the difficulty of the task and the effort involved. An icebreaker introduction, for instance, could earn the student a possible 5 out of the 20 marks allotted for that portion of the overall Group Participation assessment component. This, in turn, would leave the remaining 15 marks as incentive for those who complete the more demanding structural assignments that require students to think.

To summarise, student appreciation for and acceptance of the GLE may be facilitated through careful skills development, structured guidance and appropriate incentives. Those who venture forth, however, into this brave new world of the GLE will also need to understand and accept that the *morphing* from the FTF environment will also involve much *trial and error*. The three-stage Socratic model simply tries to set the stage. The scripting will be up to each instructor.

References

Press release by McGraw-Hill Ryerson dated 10 June 2003, 'Web-Based Technology Has Immediate Impact on Student Success in Higher Education, Landmark McGraw-Hill Study Finds', announcing the 4th annual publication of *Technology & Student Success: A Research Study on Faculty Perceptions of Technology and Student Success.* (https://www.mcgrawhill.ca/highereducation/images/studentsuccess4epressrelease.pdf). (Last accessed: 28 July 2003).

Eijl, P.J. van, & Pilot, A. (March–April 2003). 'Using a Virtual Environment in Collaborative Learning: Criteria for Success'. *Educational Technology.* pp. 54–56.

Macdonald, J. (2003). 'Assessing Online Collaborative Learning: Process and Product'. *Computers & Education*. Vol. 40, No. 4, pp. 377–391.

Mazzolini, M. & Maddison, S. (2003). 'Sage, Guide or Ghost? The Effect of Instructor Intervention on Student Participation in Online Discussion Forums'. *Computers & Education.* Vol. 40, No. 3, pp. 237–253. ■

Writing Educational (Learning) Objectives to Facilitate Student Learning

...continued from page 16

General Goal

To understand the *pedagogical principles* and general *procedure* involved in the *formulation* and *application* of *specific educational (learning) objectives* in the educational process.

Specific Educational Objectives

After reading the article readers should be able:

- To *explain* the educational implications of the terms, general goals and specific educational (learning) objectives for a given course (or lecture);
- To *write statements* that clearly convey to students the intended learning outcomes and the expected level of performance on completing a course;
- To *classify* specific educational objectives into the cognitive (knowing), psychomotor (doing) and affective (feeling) learning domains;
- To *formulate* specific educational objectives in your own course discipline according to the reviewed guidelines;
- To *reflect* on and *identify* the likely benefits and limitations in the application of specific educational objectives in your own disciplines; and
- To *design* and *plan* instructional strategies (including the selection of content, teaching methodology and assessment strategy) that will be consistent with the specific educational objectives (i.e. with the intended level of learning outcomes) formulated for the study programme.

Figure 1

intended learning outcomes as they provide useful guidelines for teachers to adopt a more systematic pedagogical approach in designing and planning instructional strategies, particularly with respect to:

- *What to teach*: Selecting content that will define the subject's intended scope and depth;
- *How to teach*: Selecting appropriate *instructional strategies* for the chosen subject (e.g. lecture, small group tutorial, *e*-learning or practical laboratory experiments) that will best achieve the learning outcomes intended;
- *How to assess*: Designing appropriate *assessment strategies* (e.g. MCQs, essay questions or open book exams) to obtain consistent and reliable evidence on whether students have achieved the intended level of learning outcomes; and
- *What to evaluate*: Appraising the quality of instruction and quality of the course programme.

Conclusion

Educational objectives therefore define more clearly for students the intent and expectations of the teacher with respect to the learning outcomes to be achieved. Thus, educational objectives can serve as a means of effective communication between teachers and learners in the educational process. Educational objectives will therefore facilitate student learning and consequently, encourage and empower students to take greater initiative and responsibility to direct and to manage their own learning. ■

Peer Tutoring—An Effective Strategy to Promote Student-centred Learning

...continued from page 4

Student-tutors presenting their ideas by role-playing

A student-tutor supervising the work of tutees

Tutees participating in a class activity

is cognizant of certain constraints. By setting realistic expectations of the student-tutors (bearing in mind factors like some of them may not be good teachers as yet, or that the level of instruction may not be always appropriate) and being willing to set aside time to guide the students throughout the process, peer tutoring can be implemented to achieve the desired outcomes for both the student-tutors and the tutees.

References

Association for Supervision and Curriculum Development. (1995). *The Multiple Intelligences Video Series*. Alexandria, Va.: ASCD.

Beasley, C. (1997). 'Students as Teachers: The Benefits of Peer Tutoring'. In Pospisil, R. & Willcoxson, L. (Eds.). *1996 Teaching and Learning Proceedings*. Perth: Academic Services Unit, Murdoch University. pp. 21–30.

Gardner Howard. (1993). *Multiple Intelligences: The Theory in Practice*. New York: Basic Books.

Goodlad, S. & Hirst, B. (1989). *Peer Tutoring: A Guide to Learning by Teaching*. London: Kogan Page Limited.

O'Donnell, A. & King, A. (Eds). (1999). *Cognitive Perspectives on Peer Learning*. Lawrence Erlbaum Associates.

Wallace, J. (1996). 'Peer Tutoring: A Collaborative Approach'. In Wolfendale, S. & Corbett, J. (Eds.). *Opening Doors: Learning Support in Higher Education*. London: Cassel Publishers. ■

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