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*This issue of CDTL Brief is the first of a two-part installment that features the teaching practices of the **NUS Outstanding Educator Award** winners and nominees.*

Balancing Content-based Education and Process-based Education

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Teaching philosophy

My teaching philosophy is to make students competent on the subject matter using a good balance of content-based education and process-based education. I will use the materials from a senior undergraduate module, CS4251 "Strategic Planning for Information Systems" which I have taught for several years to illustrate this philosophy. The desired learning outcomes of this module are:

1. To equip students with latest knowledge on the subject matter,

2. To make students confident to learn on their own about the subject matter.

The first outcome is achieved through content-based education which imparts knowledge on the subject matter to students so that they can quickly become proficient in the workforce. But using the traditional mode of education alone is inadequate for fast moving fields like information systems where knowledge becomes obsolete quickly. The second learning outcome is achieved through process-based education which equips students with lifelong learning skills so that they can effectively adapt to changing situations and remain valuable to their organisations in the future. Achieving both outcomes depends on having an appropriate balance of content-based education and process-based education.

Teaching methodology

Content-based education is achieved through the use of teaching materials such as recently published textbooks, relevant articles published in top journals and numerous contemporary real life cases of renowned, forward-looking organisations to illustrate the concepts taught. For example, linkages between strategic business planning and strategic information systems planning are illustrated using real life examples from British Petroleum. The various types of strategic information systems planning approaches are taught with real life examples from General Tire, American Express, Caesars Palace and BMW. Key strategic information systems planning tools (critical success factors, value system and resource life cycle) are taught using real life examples from Walmart, Microsoft and Dell.

For Process-based education, students are assigned two big projects which are done with my intensive supervision because students lack the experience to complete such projects.

Project 1 is case-based. Students are given cases of product-based and service-based organisations

and expected to read up on the cases and gather additional information to familiarise themselves with the organisations. I guide the students in applying the latest strategic information systems planning tools to generate creative solutions to real life problems in actual organisations (represented by the cases given to students). Students then generate creative solutions to real life problems identified in these organisations during the consultation sessions. Business environments may change in future but this skill of applying strategic information systems planning tools to generate creative solutions to real life problems will always be valuable. In fact, such projects have yielded interesting solutions that correspond to actual future actions taken by these organisations.

Project 2 is research-based. Students carry out research and gather materials from journals, magazines or the Internet on emerging technology trends that affect strategic information systems planning. During the consultation sessions, I help students identify emerging technology trends, conceptualise the materials about these technology trends and interpret the implications of these technology trends for strategic information systems planning. Finally, students synthesise all these materials in the form of a report.

Business environments may change in the future but this skill of identifying emerging technology trends and interpreting the implications of these trends for strategic information systems planning will always be valuable. This assignment has yielded valuable interpretation and synthesis of technology trends. To date, two articles[1,2] (which I co-authored with students) arising from this project have been published in a top practitioner journal in the field of information systems. At the end of both projects, students present their work in class for mutual learning purposes.

Assessment tasks

The two big projects account for 60% of the module grade. Both projects correspond to critical skill sets in the work of strategic information systems planners. These skill sets have been identified with the assistance of senior practitioners in the industry.

The articles resulting from Project 2 can be used to educate students on how technology trends can drastically change industry dynamics and how strategic information systems planners should pay attention to such technology trends. Indeed, these articles have been used in several universities in North America, Europe and Asia-Pacific for teaching purposes.

The final examination accounts for 40% of the module grade. It assesses the students' understanding of the materials taught in the module as well as their ability to apply key concepts to real ife situations (in the form of actual examples). Such questions serve to differentiate between the stronger and the weaker students. Students get the opportunity to vote on whether they want an open-book or a close-book examination.

Summary

CS4251 was developed with the objective of helping the students develop lifelong learning skills so that students can continue to learn about the subject matter to keep abreast of new developments. This is especially important in strategic information systems planning because new tools will continue to emerge and new technology will continue to impact the context of planning. The only way students can always remain valuable to their organisations is to have the ability to identify and creatively apply new strategic information systems planning tools (like what is done for Project 1), and to identify emerging technology trends and creatively interpret the implications for strategic information systems planning (like what is done for Project 2). By balancing content-based education with process-based education, I hope to help students to quickly become proficient in the workforce as well as to effectively adapt to changing circumstances and so remain valuable to their organisations in the future. ■

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A/Prof Bernard C.Y. Tan is a winner of the NUS Outstanding Educator Award in 2004.

Inviting Students into Our Relationship with Our Subject

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In their first lecture, students are meeting two strangers—the lecturer and the subject. I feel that teaching is not just about a lecturer facilitating the learning of a subject. It is perhaps more significantly about the lecturer's relationship with the subject. Many of us are motivated to become teachers because we feel a deep kinship with a subject and we find it meaningful and fulfilling to bring our students into that relationship. More broadly, we hope that students will, through their experience with us, appreciate the joys of seeking knowledge for its own sake. In this brief paper, I want to share some of my beliefs and associated goals in my own efforts to engage students in that relationship with my subject—transport.

Spirit of enthusiasm and exuberance

When a lecturer is seen to enjoy doing work in his/her field and is excited about sharing this passion, it has the effect of raising students' interest and curiosity. The spirit of exuberance for learning, if visibly demonstrated, can have a contagious effect on students. Likewise, lecturers who actively participate in their subject in various ways, through research, community work, consultancies or other avenues and who bring insights of these experiences to their class are capable of adding much value to their teaching. Students become really interested and take pride in knowing how their lecturers have helped to directly bring about improvement in the human condition, beyond just raising the awareness of the problems and issues in the classroom context.

Lecturer as a facilitator of learning

In the conventional approach to teaching, lecturers show students how something works within their subject. While quite a lot of ground can be covered using this approach, little creative and critical thinking takes place and whatever is learnt is quickly forgotten. In the constructivist approach, lecturers guide and assist students in discovering for themselves how something works. It builds on the existing knowledge and experiences of students, using various problem-solving and inquiry-based learning activities. The approach works best when students are put together in groups to collaboratively formulate their ideas, develop inferences and make presentations of their knowledge.

An exclusive reliance on this approach however, has its limitations as students may lack sufficient knowledge to begin with and consequently, only a few topics can be covered as the process can be time-consuming. Therefore, a good balance has to be struck between active/independent learning and a more directed learning that provides ground rules and preliminary insights.

In my own teaching, I use a mixture of the conventional and constructivist approaches, assisting students to discover the foundations, giving them preliminary ideas and material and then getting them to intuitively form their views and conclusions. I have found that students often come up with innovative ideas and frameworks that are quite inconsistent with what is observed in the real world. Explanations are sought to account for these discrepancies and a more authentic learning takes place in this process. In this way, students have some opportunities to take ownership of their own learning. I often learn new ideas and perspectives from my students and make it a point to tell them when this happens so that they can feel a sense of accomplishment.

Breaking the anxiety barriers

If you are in the teaching profession, I believe that it must be partly because your own experience as a student was enriching and fulfilling. By telling little stories of my past student life, snippets of the joys as well as the tribulations, I introduce brief moments where I relate to my students more as a friend than

as a teacher. I have found that sharing my student experiences calms the students, reduces their anxieties and opens up the space for learning.

Another means of opening the space for learning is to instill in students a deeper sense of belonging to the class. In this direction, it helps if you know the names of your students. This has been a big challenge for me especially in big classes. In my first discussion session, I get my students to say something about themselves, particularly what they like and dislike about university life. I take notes and try to remember their names through association with what they have said. I feel that when students are called by their names, a more authentic connection is established with them. They feel that they matter and there is also a greater sense of responsibility to the class when they are no longer seen as anonymous.

An interactive learning space

The best learning environment is one that nurtures interaction not just between the lecturer and students but also among students themselves. For this to happen, the learning space has to be well-managed and hospitable, "not to make learning painless but to make the painful things possible, things without which no learning can occur—things like exposing ignorance, testing tentative hypotheses, challenging false and partial information, and mutual criticism of thought" (Palmer, 1993: 74). In my modules, I usually spend some time talking about the need to embrace a culture of constructive criticism and feedback.

Criticism can affect self-esteem and can bring about either rash defensiveness or fearful detachment. Thus I feel it is important to ask students to take criticism in a good spirit, as it is directed at a viewpoint rather than at the person expressing it. A process of well-coordinated interactive learning environment that allows for debate and discussion can help to nurture the students' confidence and acceptance of alternative viewpoints. Students get to appreciate that 'one size does not fit all' and that there are limits to the application of models, benchmarks or best practices to contexts with different cultures and conditions.

Beyond the classroom

Engaging with the real world means moving beyond the traditional classroom. It is therefore useful to bring the class to the field, and if that is not possible or feasible, to bring the field to the classroom, through slide shows, videos and seminars by guest speakers from the industry. Students actually like to experience a variety of activities in their learning environment. The experience of going into the field, engaging with the practitioners and seeing the real world of transport, give new meanings to descriptions and explanations learned in class. In their assessment, I give the students a variety of exercises that involve independent and group assignments, but I try to include at least one that allows the students to express and see themselves in their work.

Keeping a focus on the more responsive students

There will be the occasional students who appear disinterested or uninterested when you are conducting a lecture or discussion. Such students are physically present in your class but seem otherwise preoccupied with other things. Unless they are actually disrupting the class in some way, I do not let such students intimidate or detract me. I shift my focus instead to those students who express attentiveness and eagerness to learn. If you believe that you have something meaningful to impart and remain committed to that purpose in your practices, over time, at least some of the students will appreciate your attempts to connect with them, and will reciprocate with a more concerted effort to listen and learn.

Conclusion

We all have different teaching styles and goals. We preferentially focus on different types of instructional tools, tend to emphasise different learning outcomes and involve different levels and modes of interaction with students. Similarly, students have different personalities, learning styles and interests. Sometimes there is a mismatch and we are left wondering if these students would have chosen to take our module if they knew what they were in for. We must recognise that it is possible that our efforts may only touch a small segment of the class, but still we should try to take comfort in our little achievements and persevere on, especially if we love what we do.

References

Palmer, P. J. (1993). *To Know as We are Known: Education as a Spiritual Journey.* San Francisco: Harper San Francisco. ■

My Teaching Philosophy

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The subject area–the law of real property

A great authority on the [English] law of real property prefaced his 1878 lectures with the following:

> *"Some of the most remarkable of these laws, viewed by themselves, apart from their history, and judged only by the benefits which now result from them, appear to me to be absolutely worthless. Others are more than worthless, they are absurd and injurious."*

More succinctly, Cromwell described the law of real property as "a tortuous and ungodly jumble." In a somewhat amusing confirmation of the above, Maitland said:

> *"When those who are set to teach the youth hold such language as this, there are but two courses open to us—to silence the professors, or to reform the laws."*

Last but not least, Sir Robert Megarry, one of the leading textbook writers of Property Law said that he:

> *"always felt much sympathy for those embarking on a study of the law of real property" and that "as an undergraduate, the subject seemed...Complex, endless and dull."*

If these are what the pundits on the Law of Real Property have to say about the subject, what is a teacher in this field to do? 'Silencing' this professor was not an option; nor was I in the position of being powerful enough to 'reform the laws'.

Additional difficulties

In addition to the acknowledged difficulties of the subject area, there are other obstacles to consider when teaching my undergraduate (RE2103 "Property Law I" and SSD1203 "Real Estate Development and Investment Law") and postgraduate (MPM5103 and MRE6101 "Legal and Institutional Framework") students. Firstly, many of the laws governing Singapore have been transplanted from England as a result of colonisation despite the fact that these laws are vastly incompatible to Singapore's unique situation. In addition, many pieces of local legislation were passed to cater to Singapore's unique problems (especially land scarcity) and these had to be grafted onto existing English legislation.

Secondly, since most of the students in my class have taken relatively easier Law subjects such as Contract and Tort, they relate better to the latter than to Real Property Law, which requires a sound grasp of fairly abstract concepts. In general, students respond better to concepts such as entering into a contract to buy, for example, a computer or some other consumer products, or be able to identify a tort by reading a newspaper report of a car accident. It is unlikely that they will be able to relate to buying a house or apartment or creating a trust instrument.

To compound the above listed difficulties, the students in this module come from different faculties, with varied levels of understanding of Law. This meant that my module was just *one* of the various modules they were doing. Not only do I need to instill in the students a certain *type* of thinking and a certain *type* of reasoning, I also have the additional task of making it relevant both to the other modules they are currently pursuing as well as their choice of career paths.

Faced with all these odds, I knew that it was critical for me to find ways to make the subject appealing

and relevant for my students. Thus, I have come up with the following teaching approaches and learning objectives. Primarily, I seek to instil in students an interest in the subject which would in turn lead to:

- A greater involvement in their preparation and participation in the module,
- A greater awareness of the relevance of the topic to their general daily lives as well as to their future careers,
- A deeper engagement with the other modules they are pursuing, for example: Valuation, Property and Facilities Management, Urban Planning and Land Use.

My overall teaching approach

Within the classroom, I adopt an interactive style of teaching, incorporating elements of both lecture and tutorial sessions, hence providing a conducive learning environment. This is complemented by a maieutic approach, where student responses are provoked by my seemingly innocent questions. One of the comments from my student's feedback form was "She gave us a heart attack!" However, I take this positively because I know I make my students think on their feet, question their own assumptions and demolish long-held beliefs. In other words, I *spar* with my students. It is important to me that students use the right words to articulate their thoughts. I need to ensure that they have actually understood a particular concept, and thereby able to link it with previous ones, and also recognising the significance of the topic in a bigger context of the industry.

I am a little harder on the postgraduate students but they take my 'treatment' well and have been robust in their comebacks. Some of the frameworks I have used in my teaching include the Case-Method, Problem-Based Learning, Role-Play and Debates.

Outside the classroom

This can be anywhere, be it along the corridors, in the canteen or on the IVLE. Students are expected to think about issues raised in class whether it directly relates to typical textbook matters or not. They are to look for legal angles in everyday events. My trigger resources are varied—from movie sources (*Intolerable Cruelty* is about a pre-nuptial agreement and the division of matrimonial assets), headlines in tabloids (e.g. reports on spouses in divorce proceedings squabbling over their share of the matrimonial home) or a picture in the morning's *Straits Times* (e.g. a report about sewage water leaking into water tanks at one of the condominiums not far from NUS).

After lessons, I frequently receive emails from students about real-property related issues they recognised from their everyday lives. It is heartening that they want to know more and beyond what the textbooks tell them—students have begun connecting the dots among disparate matters we have learnt about life. This is when I know that I have got them 'hooked' and that I have paved the way for their independent and self-directed learning. ■

Teaching a Very Large Class: What to do? How?

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Teaching a large class is often an unwelcome assignment due to many vexing problems associated with the sheer size of the class. These problems include dealing with how to encourage attendance in large classes, how to prevent academic dishonesty, how to get feedback from students about the course and how to make a big class interactive. Like other classes, "large classes work best when students take an active interest in the subject and when teachers personalise their presentations and respect their students. However, while these basic principles of good teaching apply in large as well as small classes, the sheer number of students in a large class can magnify some problems that might be more manageable in a smaller class" (Enerson, Johnson, Milner & Plank, 1997). The teaching of large classes is therefore challenging. "Large classes are not necessarily less effective than smaller ones, but they do require more conscious effort and planning" (Enerson, *et al.*, 1997). Also, the innovative use of modern day tools such as IT, communication technologies and the Internet can help overcome some of the problems associated with teaching large classes.

So, what is large? If 'large' is defined as 100 or more students per class or "one that has too many students to learn names by the end of the semester" (Enerson, *et al.*, 1997), then a class of 1400 students is ultra large. Such is the typical size of a class taking the module EG1109 "Statics and Mechanics of Materials" which I have been teaching at the Faculty of Engineering for the past few years. While this article will not address all the various issues and difficulties associated with teaching very large classes, it would focus on describing some specific techniques I employed to overcome some difficulties inherent in the teaching of large classes.

Participatory workshop lectures

A major challenge that one often encounters when teaching a large class is how to engage the students in active learning throughout the lesson as students tend to be passive in the learning process especially in a lecture theatre. Using the monologue way to teach large classes does not attract students to attend classes. The problem is further compounded if the materials presented during such lectures are taken directly from the textbooks and/or lecture notes. In such a situation, only outstanding speakers would be able to hold the students' attention for the entire period. There is therefore a need to promote students' interaction in class to help them focus and sustain their attention on the underlying concepts.

In a bid to stimulate students' interest in the module and hold their attention for the entire lecture, I have adopted a participatory workshop-lecture teaching technique where interactions between the lecturer and students as well as amongst students are encouraged. In such workshop-lectures, students worked with me through the lecture materials (published in the form of a book) that contain partially blanked-out portions at critical locations. By working through the notes, students are not only actively engaged throughout the lecture but also given the opportunity to think at each step and literally learn on the spot. Short concept quizzes with multiple choice answers are also posed at appropriate moments and students are encouraged to discuss with one another to arrive at the correct answers to these quizzes.

Editable PowerPoint slides

Whilst teaching with PowerPoint slides offer crisp, clear and quality presentation, it can sometimes be too fast for students to follow compared to the chalk and blackboard or markers and overhead transparencies method. Another disadvantage of using PowerPoint slides to teach is that lecturers are unable to do live editing (e.g. highlighting or inserting additional notes) on the slides, which is often required to reinforce certain points. In an effort to combine the advantages of both PowerPoint and traditional blackboard modes of teaching, PowerPoint slides with blanked-out portions are presented during lectures. Thanks to the advent of the Tablet PCs and pen-based computing, I can edit the slides live using a pen and coloured electronic ink (see Figure 1).

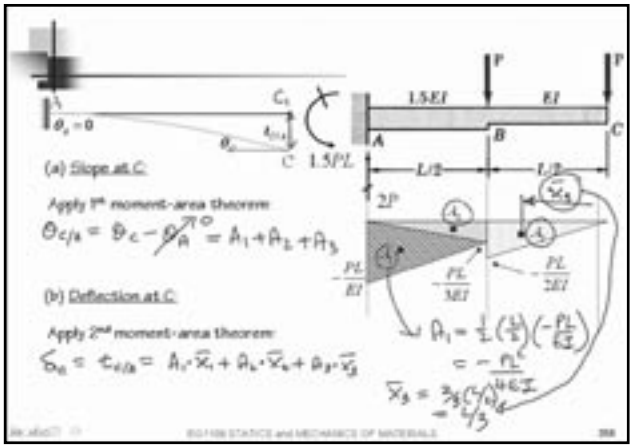

Figure 1. Writing on PowerPoint Slide

This method combines both the advantages of PowerPoint slide presentation and the advantages of teaching with the traditional blackboard. For more effective communication and explanation of difficult concepts during lectures, I use the various animation features permitted in PowerPoint. The use of animation and live editing of the PowerPoint slides has helped me to conduct lessons for a large class the effectively.

IMPARO—An advanced web-based tutorial system

Almost all online Courseware Management Systems (CMS) focus too much on file management (e.g. management of lecture notes or course content) but too little on tutorial and assessment for students. The lack of online tutorial and assessment makes the existing CMSs incomplete. Realising this shortcoming of the existing CMSs and the fact that web-based education is becoming an important field, an innovative advanced web-based tutorial management system called IMPARO was developed by the Faculty of Engineering and used to create e-Tutorials for the module EG1109. The IMPARO system boasts of numerous innovative features including one that allows the lecturers to manage and create e-Learning tutorials effortlessly in a Do-It-Yourself (DIY) manner without any HTML or JavaScript programming knowledge. IMPARO also subsequently serves as a hosting platform for online learning when students do these tutorials at their own pace.

While most online evaluating systems lack advanced diagnostics capability and are limited only to multiple choice type questions, IMPARO features a wider variety of question types—numerical, symbolic, multiple choice and essay question. The symbolic question feature (see Figure 2) is particularly interesting and innovative. It is intelligent enough to recognise and mark correctly the almost infinite ways of answering a symbolic question.

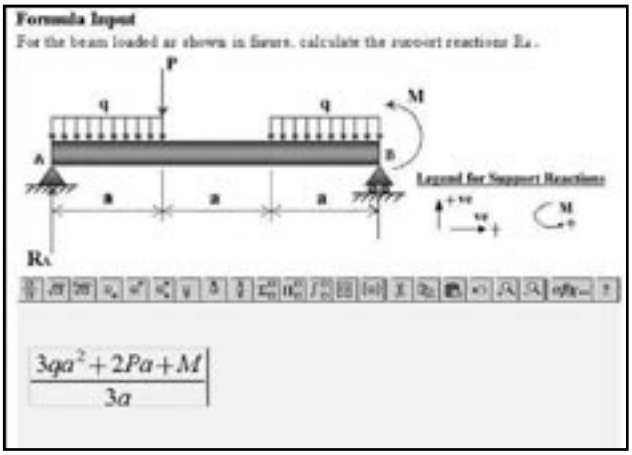

Figure 2. Symbolic Input Type Question

Another major innovative feature of IMPARO is its ability to allow educators to create online tutorials with advanced diagnostic capabilities by 'training' the system to diagnose common mistakes which students would likely make during problem solving. To discourage copying, the parameters used in the questions are automatically randomised and unique for each student. Students may also practice the same question as many times as desired since the values of parameters used are different each time. Students are

thus able to learn and progress at his/her own pace, which is not possible in a traditional classroom-based tutorial.

Another powerful feature of IMPARO is its comprehensive monitoring and assessment capabilities. From the monitoring window, lecturers can monitor the students' performance at a glance so that students who are lagging behind can easily be identified from a large group and rectified at an early stage. Lecturers are also able to identify the questions which the students have difficulties in solving and follow-up with a further explanation of the solution.

Virtual beam experiment

The availability of high speed network bandwidth coupled with advances in PC speed makes it possible to 'bring' the laboratory to a large group of students in the form of virtual experiments. To overcome the limitations of traditional physical laboratories, a web-based virtual laboratory on a simple beam experiment has been developed (illustrated by a sample snapshot in Figure 3).

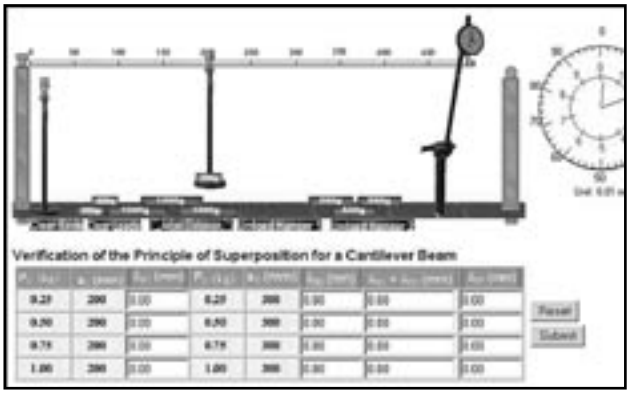

Figure 3. Virtual Simple Beam Experiment

The virtual beam experiment is a computer simulation of the actual physical experiment using realistic graphics and images which allows students to 'conduct' the experiment conveniently over the web in an open-ended manner just like in the actual physical experiment where learning takes place through doing the experiment. The intention of the development for this particular module is to encourage the students to go through and be familiar with the concepts and procedure before going to the physical laboratory to conduct the actual experiment. To make the virtual instrument feel more realistic, multimedia animations allow the students to observe the effect of loads on the virtual beam. The system will record and mark automatically whatever results submitted by the students. With the adoption of the virtual experiment, students taking the module were able to conduct their experiments anytime, anywhere without any worries about the scheduling problem despite the enormous class size.

Conclusion

The teaching of large class is truly challenging and requires more conscious effort and planning in order to make learning and teaching more effective in such an environment. With the innovative use of modern day tools such as IT, communication technologies and the Internet, some of the problems associated with teaching large classes can be overcome. Finally, it is important to note that unless there is continuous effort and readiness to innovate and evaluate one's teaching practice to improve the way one teaches, stagnation (regression) in teaching performance may well occur.

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The Art of Teaching a Science GEM

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Designing and teaching a General Education Module (GEM) presents a unique set of challenges. Unlike a normal module, a GEM typically consists of students from different faculties, with diverse backgrounds, abilities and expectations. Some students would choose a GEM out of interest, while others may feel compelled to take it just to fulfil the University's requirements. How does one then go about teaching the GEM to such a cohort of students, to make it a meaningful learning experience for everyone and realise the University's goal of providing general education at the same time? In this article, I would like to share my thoughts on this issue by drawing from several years' of experience in teaching GEK1508 "Einstein's Universe and Quantum Weirdness". While there is no magic formula that would apply to all GEMs, I hope that some of the points raised would be relevant to other Science GEMs.

GEK1508 was designed specifically for non-physics students with the aim of introducing them to the two pillars of modern physics—Einstein's theory of relativity and quantum theory. It is an indisputable fact that these two theories have profoundly affected the intellectual, technological and even cultural[1] history of the twentieth century and have proved to be of wide interest to non-physicists. Thus, an appreciation of the ideas behind these theories is very much in harmony with the goals of general education, and this module strives to achieve precisely that.

So, how does one go about making abstract concepts of modern physics accessible to students with only O-level physics? The key point is to emphasise the main concepts and ideas behind the theories while omitting the technical details. For example, instead of going through the derivation of Einstein's equation $E=mc^2$ (which may not be important for a non-physics student), I would rather focus on the equation's implications such as why it makes nuclear power possible. Wherever possible, I use analogies to illustrate the points I want to make. By comparing and contrasting with the familiar, students can not only understand these abstract concepts more easily, but also appreciate how they differ from the physics of everyday experience.

But making modern physics understandable to the students is only half the story. How does one get even the most jaded student to be interested in the subject, to see the value of this knowledge and to be motivated to learn more? The following are a few strategies I adopt to achieve this:

- *Make the lectures interesting*. I see myself not so much as a lecturer, but as a 'tour guide' introducing new worlds—such as the earliest moments of the universe or the inner structure of atoms—to the students. Each lecture is like a virtual tour, in which I describe and explain these worlds with the aid of attractively prepared slides that are clear and concise. To supplement my explanations, I make use of multimedia, Java applets and even the occasional 'live' demonstration, all of which never fail to capture the students' attention.

- *Explain the relevance of what is being taught*. I always try to connect what I teach to other subjects or to everyday knowledge in interesting and unexpected ways. For example when discussing the death of stars, I ask the students if they knew that the iron in our blood originated from a supernova explosion billions of years ago. I use such 'titbits' of information to arouse the students' curiosity and hopefully motivate them to learn more about the subject.

1. Indeed, Albrt Einstein was chosen by *Time* magazine as the Person of the Century, not just for his scientific accomplishments, but also for the fact that his ideas "reverberated beyond science, influencing modern culture from painting to poetry" (Golden, 1999).

- *Display a passion for the subject*. Although it is easy to detect a teacher's passion for a subject, it is perhaps more difficult to describe how one can achieve this as the passion has to come from within. It certainly helps if the subject you teach is also your chosen area of expertise as it is in my case. As Ghai (2004) has noted, a passion for the subject and a dedication to teaching would naturally rub off on the students and motivate them to them to put in their best in the module.

Non-standard physics questions

Some of the points mentioned above also apply to the tutorial, test and quiz questions of GEK1508. The questions I set are quite unlike the standard physics questions which usually involve calculations and derivations. Rather, they attempt to test the students' conceptual understanding of the lecture material or their ability to link it up to other bodies of knowledge. For example, a standard question on length contraction in special relativity might be:

> *Calculate the length of a 10-metre-long spaceship that is moving past you at 90% the speed of light.*

Most students would be able to answer it if they had the correct formula in mind, even without a proper understanding of this effect. Thus, I would instead prefer to ask the following:

> *Imagine a pole-vaulter that is running past you at 90% the speed of light. Would it be harder for him to jump over the hurdle, now that the pole is contracted?*

This question is definitely more interesting than the previous one and the correct answer requires a proper understanding of the length-contraction effect. Furthermore, by incorporating an abstract effect in a familiar situation, students are able to relate to it more easily, and may even be more curious to know the answer. I have encountered students who simply could not get this question out of their minds until they had the correct answer!

An unorthodox term paper

Perhaps the most unorthodox component of GEK1508 is the term paper, which replaces the final exam. The decision not to have an exam was made because it would duplicate what the two term tests have done (testing the students' understanding of the lecture material). As a GEM, there is a limit to the amount of knowledge the module can cover beyond which it would be too specialised. Having a term paper would be able to instil other valuable skills in the students as I will explain below.

The objective of the term paper is to choose a topic in modern physics and write a 3000–4000-word short story based on this topic. Furthermore, the story has to be pedagogical in nature, explaining or illustrating aspects of the chosen topic. This is inspired by the well-known Mr Tompkins stories (Gamow & Stannard, 1999), which explains modern physics through the adventures of a bank clerk, Mr Tompkins. Often, Mr Tompkins would fall asleep during a physics lecture, and find himself in a dream world where he is able to experience the effects of relativity or quantum theory in everyday situations.

Why did I choose the short-story format rather than a literature review, which is more typical of a Science term paper? In fact, I used to adopt the latter format. But I realised that students were merely regurgitating the information they found in books and websites. In certain cases, it was not even clear if they have understood the information. So in the past semester (Semester II, AY 2003/2004), I decided to switch to the short-story format. I reasoned that it would be a better way to gauge the students' understanding of the chosen topic, as a certain level of comprehension is needed before one can actually begin writing a meaningful story based on the topic. Furthermore, such a format would encourage creativity in the students as they have to find original ways to interweave fact with fiction, in order to effectively explain or illustrate physics concepts. The ability to understand information, to apply it creatively and to explain it clearly are skills that will be valuable to the students even outside of physics.

Initially, some of the students were apprehensive when they learnt of this term-paper assignment. Typical reactions were: "I have never written a story before", "I have never been good with languages and my creativity is limited" and "This sounds more like an Arts term paper than a Science one." However, after explaining

my rational for giving them such an assignment, I think a good number were convinced that this might actually be a beneficial, if not an enjoyable, learning experience.

Now that the semester has ended and I have finished reading the term papers submitted, I am on the whole impressed by the students' creativity and efforts. Amongst the best was one written in the form of an autobiography of the valence electron of a potassium atom, from its 'birth' till its 'marriage' with an electron of a bromine atom. Another term paper describes a court case in which a certain Mr Black Hole is on trial for 'murdering' someone who had wandered too close to him. Yet another one tells of a day in the life of a psychologist, whose patients includes a character called Light that is troubled by its wave/particle split personality. Never did I imagine myself reading a term paper like I would an irresistible bestselling novel. But that was the effect these three and a handful of other term papers had on me!

Conclusion

In conclusion, teaching a GEM has been an educational experience for me. I have learnt that it is very different from teaching a normal physics module. Apart from the primary aim of introducing modern physics to the students, I have found myself trying to instil in them some 'softer' qualities, such as a life-long passion for learning and the ability to think and write creatively. But there again, isn't this what every Science GEM should strive to do?

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