Motivating Learners: No Such Thing As A ‘One Size Fits All’ Approach

In their introduction to *Inspiring Students* (1999), Fallows and Ahmet inform us that the educator’s key role is to inspire students to become independent and well-motivated learners. They assert that “educators must not only transfer factual items of knowledge and introduce key debates of the subject to students, they must also deliver enthusiasm and influence students to learn” (pp.1). It is certainly true that “motivation...is a powerful factor which affects learning” (Pan, 2008). In fact, Wlodkowski (1999) adds that “engagement in learning is the visible outcome of motivation” (pp. 9), and this is certainly borne out in the teaching experiences our contributors share in this issue of *Brief*.

A common thread that runs through these articles is the recognition that there is no one-size-fits-all approach to motivating students to learn; it involves a combination of different strategies and curriculum design methods. Whether it is introducing biology majors to statistics to help them overcome “statistical anxiety” (*Dr Peter Alan Todd* shares the challenges and benefits of doing this on pp. 5) or formulating an effective remediation programme to prepare students of Pathology who struggle with the subject for their supplementary exams (as related on pp. 2 by A/P *Tan Kong Bing* and *Dr Nga Min En*), our contributors have implemented a wide array of strategies, both tried-and-tested as well as unusual ones, in order to create classroom environments that are conducive to boosting their students’ motivation to learn their respective subjects. One of the more radical methods *Dr Wong Boon Seng* (Dept of Physiology) used to engage students taking his advanced neuroscience module was to cut the content and present only key concepts in his lectures; find out what he did on pp. 10 to help his class cultivate a higher learning skill. Likewise, A/P *K. Swaminathan* (Dept of Biological Sciences) also had to think out of the box in order to engage the non-life science students taking the module “Genes and Society” which combines biotechnology and life science concepts. These include using unusual yet interesting correlations to introduce students to the basics of developmental biology and providing learning guidance through storytelling and anecdotes (pp. 13).

References


Remediation of Challenged Students: Some Experiences From Sessions in Pathology

Associate Professor Tan Kong Bing and Dr Nga Min En
Department of Pathology

Introduction

Helping students is one of our primary missions as teachers. Each year, following the main examinations, a handful of students will not make the pass grade and have to re-sit a supplementary examination in the subject in order to progress. A remediation programme is often organised to help them. Such students pose a special challenge for teachers as they often have a variety of problems. This commentary highlights three principles of remediation gleaned from both the authors’ experiences as remediators and one of the authors’ experience as the remediation coordinator in the Department of Pathology

Background of Pathology in NUS

Pathology—the study of disease—is an essential medical subject that bridges the basic sciences and the clinical disciplines. For summative assessment, Pathology was previously a stand-alone examination conducted at the end of the 4th year of the five-year Medicine undergraduate curriculum at NUS. It is now mainly taught and examined at the end of the 2nd year, as part of an integrated curriculum entitled “Abnormal Structure and Function”. Students who failed the final Pathology examinations (previous system) or the integrated examinations (current system) are called up to attend a remediation programme to help them prepare for the supplementary examinations. Initial counselling by a designated tutor helps students to identify areas that need to be worked upon, and a revision strategy is planned. The programme is conducted by a group of assigned tutors, each covering a specific topic (please refer to the example in Table 1). The students then meet with the various tutors for their remediation sessions.

Table 1. Example of a typical remediation schedule for Pathology

<table>
<thead>
<tr>
<th>Tutor</th>
<th>Topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/Prof ABC</td>
<td>Initial Session and discussion on remediation objectives</td>
</tr>
<tr>
<td>A/Prof DEF</td>
<td>Pathology of the cardiovascular system</td>
</tr>
<tr>
<td>Dr GHI</td>
<td>Pathology of the urinary system</td>
</tr>
<tr>
<td>Dr JKL</td>
<td>Pathology of the female genital tract</td>
</tr>
<tr>
<td>Dr MNO</td>
<td>Pathology of the breast</td>
</tr>
<tr>
<td>Dr PQR</td>
<td>Pathology of the thyroid</td>
</tr>
<tr>
<td>Prof STU</td>
<td>Pathology of the gastrointestinal system (plus salivary glands)</td>
</tr>
<tr>
<td>Dr VWX</td>
<td>Pathology of the respiratory system</td>
</tr>
<tr>
<td>A/Prof YZ</td>
<td>Essay question training</td>
</tr>
</tbody>
</table>
Providing a Nurturing Environment

Being positive and encouraging is one of the fundamental factors to ensuring a successful remediation programme. Weak or challenged students often have a variety of concomitant problems, including personal and social ones. It is not unexpected that their self-esteem may have taken a beating following their failure at the main examination. As such, they need a considerable amount of support, and much patience from their tutors. If there are a few students from the cohort to remediate, coaching them together is both time-efficient and offers the students mutual peer support (Winston, van der Vleuten & Scherpbier, 2010).

At the start of each remediation programme, it is helpful to meet the students individually for a chat and to understand some of their needs, respective backgrounds and problems. Referral to appropriate professionals may be indicated in selected cases. A brief analysis of their performance in the main examination would also be helpful. Through this exercise, it is often possible to uncover the reasons behind their poor performance and to formulate a suitable remediation strategy.

These initial sessions help the remediators to establish rapport with the students; it is also helpful for students to know that the relevant department is concerned for them, even though they may have failed the subject. A prospective programme which takes into account their individual needs (vide infra) is then agreed upon.

During the duration of the remediation programme itself, ‘being available’ is an important message the teacher should convey. In this electronic age, it is not difficult for the student to keep in touch with the teacher. As such, it is important for the student to know that although the teacher may often be ‘busy’, he or she is still ‘near enough to care’. However, this caring approach should be balanced by the teacher setting out clear objectives for the student. It is important for the teacher to emphasise that it is the student’s primary responsibility to drive his or her own learning.

To avoid a situation in which students end up being spoon-fed, they should be asked to make specific preparations before each session, in order to maximise their learning.

Providing Optimal Content Coverage

The remediator should have a thorough understanding of the knowledge and concepts required by the students to be successful in the supplementary examinations. It is critically important that both the teacher and student have a firm grasp of the topics that are of core importance. The remediation programme should cover as much of the core syllabus as possible and some of the ‘good-to-know’ topics. A remediation timetable may be mutually developed so that students can chart their revision and concentrate on specific topics. The face-to-face sessions can be conducted using a wide array of formats, including sit-down discussions on important topics, quizzes which test the students’ responses and understanding, mock essay questions as well as case-based or problem-based discussions. Having these students exposed to a wide range of learning strategies and formative assessments would help them in conceptual integration (Winston, van der Vleuten & Scherpbier, 2010). All available learning resources should also be considered. An abundance of practice question material with commentaries is available both in traditional and web-based formats. Past year questions are often available through the NUS library website and these resources may be consulted for learning and exam preparations.

In addition, co-opting a small panel of departmental colleagues to help these students provides a boost for the remediation process. Having a few teachers, each contributing a little to the remediation process, helps to provide a balanced remediation programme. A coordinator also needs to be identified among these colleagues and may receive useful and independent feedback about the students’ revision progress. Having a panel of colleagues in the programme helps spread out the teaching workload within the department, provides each contributor with an additional

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teaching indicator and also helps share the credit (or responsibility!), no matter the students’ performance in the supplementary examinations.

**Ensuring Flexibility**

Flexibility in the timing and nature of the remediation sessions is another important aspect of ensuring the programme’s success. This is pertinent as teachers often have heavy concurrent duties (e.g. administration, clinical service work, teaching, etc) and the students may have other assignments to attend to (e.g. repeat clinical postings, etc) and personal problems to resolve. The frequency of these sessions and the duration of each session are probably not as important as the mutual commitment made by both the student and the teacher to meet regularly and to cover all items on the core agenda (*vide supra*).

Flexibility also means accommodating different remediation styles and formats. In fact, having varied remediation styles and formats can help address the needs of different students. For instance, the truly challenged students may require more face-to-face discussions with their teachers with a focus on tackling case-based questions and ways to approach common problems. Meanwhile, students who are more independent and motivated may prefer to be given written assignments and meet with their teacher at a later date to discuss areas for improvements.

**Student Feedback**

Over the years, students who have gone through the remediation programme have provided favourable feedback. Notable comments have ranged from comprehensive ones such as: “[t]he tutorials were great for focussing our studies and clarifying doubts/questions”, to a simple “[t]hank you for everything you have done”. Many of the students have gone on to clear the examinations and subsequently to qualify as medical doctors.

**Conclusion**

As universities aspire to provide world-class education and spur their students on to greater academic heights and create industry leaders of the future, it is important for these institutions to also take care of those amongst their student populace who are struggling with varsity life. It is hoped that applying the principles of cultivating a nurturing environment, providing optimal content coverage and ensuring flexibility, as shared above, would be useful to help ensure a better remediation process and outcome.

**Reference**


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**About the Authors**

**A/P Tan Kong Bing** teaches Pathology to medical, pharmacy and dentistry undergraduates. He strives to actively engage students and to make the subject matter as clear and relevant as possible.

**Dr Nga Min En** also teaches Pathology to medical, dental and pharmacy undergraduates and believes that the key to helping her students understand a topic is to always keep the big picture in sight, so that the context in which the details occur is never lost.
Background

The study of statistics is fundamental to many fields within biology, yet students tend to develop an aversion for the subject early in their schooling. For many, the point of statistics is often lost, making the subject difficult to grasp and therefore stressful. This ‘statistical anxiety’ (Cruise et al., 1985) is common among students who are not statistics majors (Bradstreet, 1996). As a lecturer and supervisor in the Environmental Biology group (within the Department of Biological Sciences, NUS), I need my students to be comfortable with, or at least have a working knowledge of, a range of analyses hence statistical anxiety is an issue that I cannot ignore.

Having taken statistics classes at high school and university, I have plenty of sympathy for those who are less than enthusiastic about the subject. At the undergraduate level, basic statistics is usually taught early on and to relatively large classes of students majoring in a wide range of subjects. Until biology students have actually gathered some of their own data, or have a clearer idea of what the subject they are studying is really about, it is very hard for them to appreciate why they are learning relatively abstract concepts such as randomness, error and significance, for example (Watts, 1991). An aptitude for statistics is particularly critical to ecology students (Panizzon & Boulton, 2004) but they frequently do not understand this until it is too late.

The following sections in this article provide some key points which I have found helpful when introducing statistics to my students.

Constant exposure to statistics

For statistics, familiarity does not breed contempt. In fact, it has the opposite effect. With repeated exposure to the subject, terms and concepts eventually sink in and consequently become less intimidating. Formulating testable hypotheses, pointing out dependent and independent variables, highlighting the analysis used, identifying controls, etc. can and should become a regular part of class (see Table 1). I find that discussing the independence of data, a common issue in biology studies, leads on nicely to multivariate approaches such as the ordination analyses we regularly use in ecology. I try not to forget, however, that deciphering graphs and other descriptive statistics is still a challenge to some students even in the third and fourth year of their degree, and that there is always room for refreshing memories and practicing these relatively basic skills (Garfield & Ahlgren, 1988).

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Adopting the Experimental Design Approach

It is not really possible to talk about statistics without discussing experimental design, “a planned interference in the natural order of events by research” (Burns & Burns, 2008). This presents another avenue to make statistics more palatable as a class will usually rise to the challenge of coming up with ideas for testing a hypothesis, problem or data set (Table 1). The data generated from these experiments have to be testable; hence, the students cannot escape the statistical implications of their designs. These are important lessons, as it is not uncommon for a student to complete the field or laboratory component of their research only to discover they have made a mistake that leaves their data unfit to verify the hypothesis. It is critical that students learn that they must design their study knowing what tests they will eventually apply to their data. It also helps that their experiment actually tests their hypothesis!

Relevance to Subject Matter/Topic

I am sure most lecturers and students would agree that teaching or learning statistics is far easier once it is possible to relate to the subject matter and/or the knowledge becomes applicable to a real data set. It is well known that a problem-based or activity-based approach (e.g. Gnanadesikan et al., 1997; Boyle, 1999) is a great improvement over simply ploughing through the equations (Snee, 1993). Working with data collected by the students themselves,

<table>
<thead>
<tr>
<th><strong>Some suggestions for how to bring more statistics into biology classes</strong></th>
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</thead>
<tbody>
<tr>
<td>(a) Spend a bit more time than usual to interpret a graph or result.</td>
</tr>
<tr>
<td>(b) Present findings in two or three different ways (for instance, the mean heart rate in Figure 1 is 66.3, but the distribution tells another story altogether).</td>
</tr>
<tr>
<td>(c) Explain the test that has been used (perhaps suggest alternatives).</td>
</tr>
<tr>
<td>(d) Ask the student what test might be applied to a particular hypothesis, problem or data set.</td>
</tr>
<tr>
<td>(e) Highlight the ingenuity (or flaws) of the study design.</td>
</tr>
<tr>
<td>(f) Discuss how a study or test could replicated in Singapore and how.</td>
</tr>
<tr>
<td>(g) Create small “buzz-groups” and give the students three minutes to consider how they would deal with a study design or statistical problem.</td>
</tr>
<tr>
<td>(h) Provide an archived data set (with the analysis done) as an example of how a particular problem might be dealt with.</td>
</tr>
<tr>
<td>(i) Plot/analyse some archived data as an in-class demonstration.</td>
</tr>
<tr>
<td>(j) Generate some in-class data and plot/analyse them for the students in class.</td>
</tr>
<tr>
<td>(k) Generate some in-class data and have the students plot/analyse them in class or at home.</td>
</tr>
<tr>
<td>(l) Collect data on a field trip and have the students plot/analyse them in class or at home.</td>
</tr>
<tr>
<td>(m) Provide a study design that the students have to go and collect data towards in their own time. Let them conduct the analysis, either in class or as an assignment.</td>
</tr>
<tr>
<td>(n) Let the students design their own studies, analyse the data collected and write up the results as a paper to be graded.</td>
</tr>
</tbody>
</table>

Table 1. This list shows a few ways to introduce statistics into the biology classes (which will usually include the findings of published studies). Examples (a) to (e) can easily be incorporated into regular lecture material. Examples (f) to (n) are more appropriate for practicals and seminar-type classes.
however, can transform learning. I can remember only one lecture from my first year statistics class. It was when we measured each other’s heart rates and plotted out the results, which looked something like those in Figure 1. My ability to interpret graphs was still poor and so I was very happy with myself when I realised why the distribution was so markedly bimodal¹. It was a big class, primarily composed of regular ecologists and biologists but with a substantial contingent of sports scientists. This latter group, mostly fit athletes, explained the first peak of relatively low heart rates!

![Figure 1. The frequency distribution of resting heart rates among students in the first biostatistics class I took as an undergraduate (reproduced from memory).]

**Source of Data to be Used**

The ideal scenario, of course, is to use student-collected data that are also discipline-specific (e.g. ecological data would be a good example for students studying Environmental Biology). Data for use in class can be generated in three principle ways:

1. **From the “field”**. In my case, this would usually be ecological survey data such as plankton diversity and abundance caught at different shores around Singapore.

2. **From “humans”**, usually as questionnaire-type data, but they could also be from a more formal experiment. For example, as shown in Figure 2, I use the time it takes humans to find different designs of ‘targets’ (stylised organisms) on complex backgrounds as a way to test aspects of camouflage theory (Todd, 2009).

3. **From published literature**. This can take time and would normally require assigning individuals or small groups to research a smaller component before pooling together the data they found. For instance, calculating the appropriateness of citations in marine biology papers (e.g. Todd et al., 2010) might mean allocating two or three journals to each student to investigate in advance.

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Getting Students to Analyse Data and Beyond

How and where to conduct the analysis? Naturally, it is better for the students to do it themselves. This could be at home, in a computer suite, in class on paper (for the brave) or in class using the students’ own laptops. It is unreasonable to expect students to pay for statistical programmes, but there is a great deal of freeware available (e.g. http://statpages.org) that you can request them to download before class. Students working in small groups and conducting the analysis during the lecture or seminar using their own machines can be very effective. A computer suite may be required if the analysis needs special software or the lecturer wants the class to become familiar with a particular programme. I have occasionally had students collect data during class and then walk through with them in real-time how I would conduct the analysis.

Once data have been collected and the analyses performed, it is easy to turn these components into a graded assignment (e.g. by having students write a full report using the data analysed). Apart from adding motivation, it helps formalise the procedure and put everything into context. Furthermore, once a student has to write up their results and methods, it is a natural step to insert the introduction and discussion too. This way, a full report gets written and the process has come full circle—from trying to get students to appreciate how statistics are central to science to them producing a paper based on their own analysis. Although some might baulk at setting their students continual assessments that require a substantial dose of statistics, I think this is what we should be aiming at. It is not possible to be an environmental biologist without first acquiring skills in experimental design and analysis. Formal statistical classes are not enough; students need to practice, in earnest, with relevant data they have collected through their own labour.

Figure 2. An experiment in camouflage. The student has to find a stylised crab against a complex background. The white spots are not eyes, but rather patches of pigmentation often found on juveniles of the model species Carcinus maenas (Todd et al., 2006)
Endnote

1. A bimodal distribution refers to a continuous probability distribution with two different modes (peaks).

References


About the Author

Dr Peter Alan Todd currently teaches LSM3254 “Ecology of Aquatic Environments” and LSM4261 “Marine Biology”. He believes that the best way to engage students is by making learning fun and relevant. He uses field trips, in-class activities and small-group work to accomplish this.
‘Seeing’ Human Diseases: Strategies to Engage Students in Deeper Learning in Neuroscience

Dr Wong Boon Seng
Department of Physiology

SM4123 “System Neurobiology” is an advanced neuroscience module with content that is arbitrarily divided into three domains: neuro-anatomy, neuro-cognition and neuro-diseases. Because of my research interest, I undertook the teaching of neuro-diseases in Semester 1, Academic Year (AY) 2009/2010. Neurodegenerative diseases are interesting and will be increasingly prevalent in Singapore’s rapidly ageing population. As this is a level-4 module, the class size tends to be small and students have to satisfy the module’s prerequisite (i.e. to have completed a level-3 module on basic neuroscience).

Motivation is one major factor in learning. It has been observed that many students in many countries (Stipek, 2011), including Singapore, are motivated by grades. While this is certainly one good way to engage students, other motivators must be in place to complement this factor. This includes ‘humanising’ the information so that students can better appreciate its relevance to everyday life (Tibell & Rundgren, 2010). This would involve linking scientific concepts and principles to students’ personal lives and interests.

In essence, students should learn to confront misinformation, challenge previously held ideas and construct new knowledge. Most effective classrooms foster students’ curiosity by engaging students through the careful planning and design of appropriate instructional strategies for the classroom environment, constantly being mindful that different people learn in different ways, and even the same person may learn a variety of things using different learning strategies (Stipek, 2011; Wood, 2009).

The following sections of the article illustrate how I have redesigned the module with the aim of engaging students at a deeper level.

Teach Less, Learn More

Given the explosion of information in life sciences research (Tang & Yeong, 2009; Tibell & Rundgren, 2010), students tend to rely mostly on rote memorisation to reproduce knowledge during the examinations. To make the situation worse, most exam questions reinforce this learning paradigm. Since the pace of research in this area is rapid, and most of the information undergoes frequent changes within a short period of time, I decided to cut the content and presented only the key concepts to students when I taught the module in AY 2009/2010. Students spent the remaining time in class evaluating recent research papers so that they can keep up with the knowledge through self-learning. This evaluation exercise also helps students promote their critical thinking skills in relation to the subject area.

Systematic Approach to Module Redesign

When preparing my lectures, I use the “backward design” approach (Handelsman et al., 2004). This approach involves three steps: (a) learning goals, (b) learning outcomes and assessment, and (c) activities. Before designing my lecture, I will evaluate the knowledge students are expected to bring in from their prerequisite subjects. I will then design the learning goals which serve as the foundation for my lecture materials. The learning outcomes will define what students should know, apply and understand after the lecture.
Adopting Appropriate Technology to Enhance Students’ Learning

To make the subject more relevant, video clips of the respective diseases will be featured prior to the start of the lecture. Video clips and images are likely to bring the subject closer to the students by making them realise that this is a real disease, show them how the patients suffer and how the family members are affected when their loved ones are afflicted with such diseases. The links to the videos are also included on my teaching webpage (http://medicine.nus.edu.sg/phys/lab/WBS_Lab/Teachings-LSM4213.html) and my lecture notes. These videos are either available on YouTube or provided free on the Internet by charity foundations in US.

In addition, I have also set up a webpage at the NUS blog site (http://blog.nus.edu.sg/bswong/). It contains announcements for all my teaching modules as well as comments on my research and other related topics. One advantage of maintaining the NUS blog site is that future students of the modules I teach can view the comments and discussion of earlier batches of students who had taken these modules.

Learning Beyond the Classroom Environment

In addition, I encourage students to attend relevant seminars by local and overseas researchers. I put up seminar notices either during my lecture or on the Integrated Virtual Learning Environment’s (IVLE) notice board. By attending the seminars, students can keep up with the latest developments and trends in the field, and learn to appreciate the ‘scientific’ process. Given the increasing interest among students in social networking platforms (Gewin, 2012), I have started a Twitter feed (http://twitter.com/bs_wong), where I post interesting research news which are relevant to the topics I teach.

Criteria-based Approach to Designing Examination Questions

Students who understand a concept should be able to (a) explain, (b) interpret and (c) apply the knowledge in a new context. These criteria have guided me in setting the examination questions. Each question will begin with an experimental situation, complete with ‘hypothetical’ or published experimental data. I will begin by testing students’ ability to understand and interpret the given data. The last part of the question will require students to apply their interpretation to current scientific concepts surrounding the topic of interest.

Outcomes and Feedback

The outcome of this teaching approach was evaluated for examination in both AY 2008/2009 and 2009/2010. When analysing the exam answers using the Difficulty Index (DI), I noted that students tend to score better when the experimental data in the exam question is presented as diagrams (DI ~ 0.8) as compared to descriptive observation (DI ~0.4).

Some student feedback for this module in the past three academic years include:

- “[The lecturer] focuses on the analysis and integration of information into knowledge, which is much needed at this level. Sometimes the overemphasis on “thinking” becomes a bit too much.” (AY2009/2010)
- “[The lecturer] promotes thinking and provides available films for further understanding.” (AY2010/2011)
- “He emphasized key concepts for the lectures which is very good as it keeps me focused during my revision.” (AY2011/2012).

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In the rapidly changing teaching and learning landscape, educators have realised that it is more important for students to hone their problem-solving skills and critical analysis than for students to simply being able to answer the typical rote-testing questions. As such, the objective of current science education should be to enhance students’ interest, engagement, and intellectual skills, as well as reducing the potentially debilitating stress which may occur if they encounter challenges along this learning journey.

References

About the Author

Dr. Wong Boon Seng currently teaches Level 3000 and 4000 Life Sciences, and NGS postgraduate modules. He is interested in using new educational technology tools to enhance interactive learning.
Motivating Learners

Genes and Society: A Life Science Module for Non-Life Science Students

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Department of Biological Sciences

Introduction

Teaching is a process of continuous learning. Almost all leading universities have teaching development centres like the Centre for the Development of Teaching and Learning (CDTL) at NUS. This underscores the importance of effective learning through teaching.

To be a good teacher, one of the prime requirements is to have passion and be committed towards nurturing students to become effective learners. Besides disseminating subject knowledge, a good teacher should also consistently review his/her course material and teaching methodology in order to enhance their students’ learning experience. In addition to these soft skills, there are several technically advanced teaching tools available to help educators. In NUS, such teaching tools can be found at the Centre for Instructional Technology (CIT) (http://www.cit.nus.edu.sg).

Nonetheless, a class or academic meeting will not fulfill its learning outcomes if the teacher and students do not have the correct mindset and do not communicate with each other in unison.

As a typical university lecturer, one of the biggest challenges I face is having to teach a wide range of students, from first year undergraduate students fresh out of high school, to final year graduate students who are almost at the end of their Ph.D. programme. Teaching such a diverse range of students requires the teacher to be able to handle classroom situations very carefully and strike a fine balance in terms of the quality and quantity of teaching. In addition to having to manage diversity among students, some lecturers face two more challenges: having to teach a large class (300 students and above) and teaching a subject to a group of students who have little or no exposure to that subject. While both are highly demanding situations, they can mould a fledgling lecturer into an excellent and successful one once the mission is accomplished. As Einstein aptly puts it, “you do not really know a subject unless you can explain it to your grandmother”.

In this article, I share my teaching experience, approach and the tools I use when I undertake an even larger challenge—teaching 600 non-life science students a module which combines biotechnology and life science concepts. In the following paragraphs, I will present the teaching strategies I employ to motivate these students, including the use of unconventional but informative correlations such as making the connection between “how babies are made” and DNA super-coiling. I will also talk about how I psychologically prepare and support my students in their learning journeys, as well as the technically advanced and basic teaching aids I use to engage students.

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Teaching First-year Students

Module content

Several curriculum planning guides (Pan, 2008) and pedagogical literature (Successful Learning, 2006) cite effective content and workload as factors for a successfully run module. For example, the two first year undergraduate life science modules which I teach, LSM1101 “Biochemistry of Biomolecules”, a compulsory life science module for first-year students and GEK1527/LSM1302 “Genes and Society”, which is taught to non-life science students, both contain the essential curricular components—lecture, laboratory practical and tutorial—with a workload distribution of 26, 16 and 8 hours respectively. While each session lasts 2 hours, the actual teaching for both modules is around 1 hour and 30 minutes. The teaching duties for such modules may be shared by up to three lecturers and they aim to prepare first year students for life science, with chapters on buffers, proteins, nucleic acids, lipids and carbohydrates. They are offered in both semesters at NUS; LSM1101 has a typical class size of 250 to 350 students, while GEK1527/LSM1302 has up to 550 students. The cohorts can be a mix both students who have GCE ‘A’ levels and from the local polytechnics, and international students who have experienced a different high school education system. The mode of assessment for both modules consist of two continuous assessment (CA) exams (20% each) and the final exam (60%) with multiple choice questions and essay type answers. On top of the academic load, a lecturer may have to be the module coordinator and oversee all related administrative duties, including smooth running of the practical sessions, exam grading and declaration of results.

Teaching strategy

In terms of my teaching philosophy, I believe that every student deserves to be motivated. The main demand made to teachers is that when they teach, they should have their students’ complete attention. The classroom is like a music hall where teaching is akin to a concert or performance. Even the slightest disturbance in one corner of the classroom can be distracting or potentially lead to a commotion. Such situations may occur more frequently in a big class.

In addition, students tend to have very short attention spans, which can be directly proportional to the module level and inversely proportional to the class size. As such, one has to bear this information in mind when adopting a particular teaching strategy. Also, no teacher has ever been successful in making all students in his/her class succeed without some additional help. There will always be a subset of students among the cohort that need that extra help and others who may not be interested to learn new things. Teachers must also remember that if a student fails a module, it can be an upsetting and memorable experience (i.e. the student will remember you forever). Furthermore, it will affect his performance in other modules. As the teacher, teaching your subject with passion and showing students you care that they fulfill their learning outcomes will go a long way in motivating them to not only learn your subject well, but also spur them on to strive to get the best possible grade.

The following are some examples from my teaching experiences on how students, even those with minimal or no exposure to a particular subject, can be motivated to follow even the most difficult topic.
Getting their attention by showing a video/graphic related to the topic—How babies are made

In the application of nucleic acids covered in GEK1527/LSM1302, students have to be introduced to the concepts of cloning and stem cells (Lanza, 2009). I prepare the class by showing students a video on a baby’s development after a sperm cell and ovum cell fuse. This video draws their full attention. Concurrently, I introduce them to the concepts of developmental biology, which slowly leads to the parallels drawn between natural fertilisation and cloning (see Figures 1a and 1b).

Students gain a better understanding of the concept of cloning when the introductory video first draws their attention. Thus one can see that being able to firmly secure our students’ attention is a major teaching strategy. Once a lecturer establishes a good approach in simplifying these concepts and proves his teaching techniques are effective in getting his students’ attention from the first class, it is likely that he will continue to be well received throughout his teaching tenure.

Providing learning guidance through storytelling—Cancer and drunkards

In this example, I show my students how a particular cancer pathway is activated by telling them a short story. There were two bad persons, A and B. One day they met and went to the pub, where B got drunk. When they left the pub, they saw a good person, C, who was holding a bad person D (eventually a friend of A and B). A and B attacked C and forced him to drink. Now C could not hold on to D anymore and released him. D, when released, started doing a lot of bad things.

This story is very easy for anyone to follow. It draws identical parallels with the activation of retinoblastoma (Venkataramani, Swaminathan & Marmorstein, 1998; Xiao et al., 2003; Flowers, Beck & Moran, 2010), a cancer of the retina which occurs mainly in children. Figures 2a and 2b on page 16 depict the parallels. The proteins Cyclin D1 and CDK 4/6 are the bad persons A and B. Phosphorylation (shown in Figure 2b as the circled ‘P’) is the drinking. The tumour suppressor protein Rb is the good person C, and the E2F transcription factor is the bad person D. Normal children do not get retinoblastoma,
mainly because the INK family of proteins in their system prevent Cyclin D1 and CDK 4/6 from combining. In addition, the p21 protein prevents the Cyclin/CDK from phosphorylating Rb, which is tightly bound to the E2F protein.

This story was well received in the class and students gained a better understanding of how cancer cells develop.

**Providing learning guidance through anecdotes—Why was the police inspector dumber than a thief?**

It is an undeniable fact that biology students do not expect much mathematics in their class. However, there will be situations where the application of some mathematics, physics or chemistry is required even in a life science class. Apart from serving as a ‘refresher’, anecdotes can come in handy if the teacher has to introduce physics concepts to the class.

For an example of such an anecdote, consider a scene commonly shown in the movies—that of a villain carrying a box full of gold bars (or coins). A police inspector would chase him and there would invariably be a fight, after which the inspector would confiscate that box of gold.

Following a simple physics calculation, the mass of the box would be

\[
\text{Mass} = \text{Volume} \times \text{Density} = (l \times b \times h) \times d = 45 \times 30 \times 10 \times 19.3 = 260550 \text{ gm} = 260.55 \text{ kg}
\]

where \( l, b, h \) are the length, breadth and height of the box in centimetres respectively, and \( d \) is the density of gold in g/cm\(^3\). By looking at the above calculation, it is apparent that it is humanly impossible to carry such a load in one hand. As a comparison, I showed some videos of world records for weightlifting. For instance, the record for the heaviest snatch of all time in weightlifting, at 216 kg, is held by Antonio Krastev of Bulgaria (Krastev, n.d.; Hed1e, 2007). In addition, the record for the heaviest clean and jerk of all time, at 266 kg, is held by Leonid Taranenko (Taranenko, n.d.; ChildsPlay2008, 2006).

In using this example, I teach students to ask the right questions when they observe that something is ‘too good to be true’. Cultivating the ability to make scientific inquiry is an important aspect of learning and knowledge generation.
**Managing common psychological learning barriers**

Each student is different, and their levels of prior knowledge, motivation, understanding and commitment will vary. Some international students would initially find it difficult to blend into the university’s academic system due to language barriers and having to make cultural adjustments. On top of these, they also have to cope with adapting to changes in the academic system and learning new teaching styles. Dealing with all these can become a burden for them. However, there are certain common questions that will have almost the same impact on each student. For example, one can start a class by asking students what job they plan to apply for upon graduation. Even though this question is not directly related to the subject matter, the discussion is very relevant to students’ lives and would immediately get their attention. They become more alert and would listen intently to how you address these questions, as they know that they are dealing with something which is very important for their future.

**Scaffolding students’ learning**

Providing such psychological preparation has been beneficial for students in helping them navigate the challenges of the module, and I have also been rewarded very well through excellent student feedback scores. Similarly, I psychologically prepare and support my students when it comes to learning the subject itself. For instance, scaffolding helps students to learn new knowledge by building on prior knowledge (Vygosky, 1978). Imagine that they must write an essay about glycolysis. To help students tackle such a big question, I break the problem down to three levels of difficulty, beginning with the simplest. This first level only requires a one-line answer that would fetch students say, 2 marks out of 10. I would then encourage them to proceed to the next level after ensuring that they completely understand the concept behind the one-line answer. Some students are able to complete all three levels at once and can even move on to additional exercises in the textbook, while some stop at the second level. Of course, in every cohort there will be some very bright and sharp students who grasp these concepts quickly and are adept at self-directed learning. Be that as it may, this strategy of breaking a big problem into manageable levels has motivated almost all students to learn at least the minimum to get some marks. More importantly, this approach ensures that no student feels left out.

**Presenting stimulus in an effective manner**

As mentioned earlier in the article, there are several advanced tools available for teaching. For example, Microsoft Powerpoint is useful for preparing handouts and slide presentations. I also make full use of the university’s Integrated Virtual Learning Environment (IVLE), where I post my slides at least one week before a class. Students can download the slides and get a printout for the class. I usually have almost the same set with some additional slides containing movies or cartoons.

The typical classroom in NUS is equipped with a writing tablet and a stylus pen. While teaching, a lecturer can write directly on the tablet so that the students can learn and discuss on the fly. In addition, these classrooms are equipped with a digital projector. These tools are indispensable for teaching, especially to a class of 350 students.

Yet, while technically advanced teaching tools are helpful, very basic stationery items like a strip of paper or a pack of index cards can also be cleverly used to explain complex biochemistry concepts. For example, I use a pack of index cards to create a DNA double helix in order to explain why DNA has a major groove and a minor groove (see Figures 3a and 3b). I also use a strip of paper to demonstrate how proteins fold and to explain the concept of torsion angles as well as the formation of secondary structural elements, α-helices and β-strands.

I also believe that interacting with students is an essential component of effective teaching.

continued on the next page...
During the practical sessions, I make it a point of walking around the laboratory to observe how my students handle an experiment. I ask them a few simple questions as a lead-in to a discussion about the concept behind the experiment. I am also mindful that technology constantly brings changes and new developments. As such, I spare no effort in upgrading and enhancing my knowledge in the use of novel teaching tools and other aids. Whenever I attend conferences or go on scientific visits, I constantly keep my eyes and mind open to tested and accepted new devices, techniques and concepts in teaching.

**Conclusion**

As emphasised earlier, teaching forms one of the most important components of a faculty member’s academic duties. A good teacher would produce good students and enabling this transformation is vital for academic, educational, industrial and all other forms of development. When a person joins an academic institution, he must undertake an oath to be committed to teaching. An educator’s knowledge will become rusty when it is not shared with others in a proper way. For most cultures and civilisations, this noble profession is truly one of the highest callings a person can aspire to.

**About the Author**

A/P K. Swaminathan currently teaches Level 1000 biology (LSM1101 “Biochemistry of Biomolecules” and LSM1302/GEK1527 “Genes and Society”) and Level 5000 structural Biology (BL5215 “Macromolecular X-ray Crystallography”). He firmly believes that “every student deserves to be motivated” and the right way to engage them is by “telling [students about] a subject at the elementary level and making them expand it with their own imagination, talent and knowledge”.

Figure 3a. B-form DNA and its major and minor grooves

Figure 3b. DNA double helix, made with index cards, with its grooves shown.
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Endnotes

1. Phosphorylation is the process which causes an organic compound to take up or combine with a phosphoric acid or a phosphorus-containing group.

2. Glycolysis refers to the enzymatic breakdown of a carbohydrate (as glucose) by way of phosphate derivatives with the production of pyruvic or lactic acid and energy stored in high-energy phosphate bonds of ATP (adenosine triphosphate).

References


