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In this issue of CDTL Brief *on* ***Research and Classroom Practices,*** *NUS colleagues discuss ways of student engagement across various disciplines in the University.*

Action Research in Teaching

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Introduction

Action research is a systematic and structured self-reflective inquiry or a small-scale intervention in the functioning of a real world social situation, with a view to understand and improve the teaching of decision-making in classrooms. This article discusses the principles and action research that could be undertaken by lecturers in their classrooms. The term 'researcher' is used interchangeably with 'lecturer'.

Principles of action research

As action research is a systematic, formative and problem-focused learning process that tries to comprehend and improve teaching and learning in classrooms, either by testing assumptions and practices or by making critical analyses of those situations. It could suggest relevant actions to enhance classroom teaching and learning in various disciplines. In fact, action research is particularly useful in the university, where different disciplines tend to require different teaching methods.

Action research is also likely to be a political process since the researcher's actions could affect students, administrators and other lecturers. Thus ethical issues such as abuse of authority might arise if researchers do not abide by 'researcher ethics'. However a protocol to obtain clearance from all participants involved may prevent such problems.

Although action research would involve the collaboration and participation of small groups of researchers initially, larger communities of researchers are expected to be included when the results are published or used by other researchers and academics for their professional development. Since the publication and sharing of the results of action research may raise the ethical issue of confidentiality, researchers should first clarify this matter with all participants before undertaking the research.

The process of action research usually commences with small changes before progressing to extensive reforms. This would usually occur through a self-reflective cycle comprising different stages such as idea identification, reconnaissance, planning, developing action steps, implementing action steps, evaluation and revision of the plan. An important part of action research is to collect several types of records including personal journals, published literature, qualitative evidence and quantitative data, all of which could be applied as a developed and critically examined justification for changes and improvements to classroom teaching.

Reasons for action research

The purpose of action research could be related to the researcher's personal interest or professional development, whereby pedagogical assumptions and ideas could be tested and developed in real life practice for the benefit of teaching and learning as well as sharing with other lecturers.

Methodology of action research

The methodology of action research would include topic selection, specification of focus, determination of research approach, triangulation of data and data collection methods, data analysis as well as the refocusing of the action research in order to achieve reliable and valid results.

Although action research topics may encompass teaching methods, learning strategies, evaluative procedures, attitudes, classroom management, administration and lecturers' continuing professional development, in reality, due to time constraints and restrictions in decision-making, the topics available tend to be limited to those where changes could be made by the lecturers themselves. As such, the focus of the action research could be derived from the selected topic by specifying the particular aspect for investigation, that is, the research question or hypothesis that states the relationship between the facts of the situation and factors operating in its context.

In order to ensure reliability and validity of the results, action research should incorporate the triangulation procedure, include introspective and empirical data, and adopt a variety of research approaches such as:

- quantitative and qualitative,
- individual and collaborative,
- complementary and intrusive, as well as
- conclusive and illuminative/heuristic.

To collect introspective data like students' and lecturers' attitudes and private thoughts, data collection techniques may encompass logs, teaching diaries, journals, personal accounts, verbal reports and field notes, which could be described as the recording of classroom teaching and learning as well as self-evaluation. Depending on time constraints and types of resources required, empirical data could be collected using structured or naturalistic observations, evaluation and trailing, case studies, experiments as well as structured, semi-structured or unstructured interviews and questionnaires.

As the ongoing dynamic analysis, verification and validation of data against the hypothesis or research question are expected to refocus the action research such that appropriate changes could be implemented to achieve the intended effects, the data analysis stage of the action research process is the most crucial stage in pedagogical development.

Conclusion

Action research is a useful tool that could be employed by the individual researcher or in collaboration with other researchers to work through self-inquiry cycles of planning, action, observation and reflection, with a view to collect classroom data and records that could serve as a justification to develop ideas and action steps that improve their teaching and facilitate students' learning.

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Major Challenges Instructors Face in Teaching Undergraduate Contemporary Life Sciences

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Instructors of life sciences are often confronted with at least two major challenges—how to impart skills such as scientific knowledge enquiry and acquisition, and how to bridge the gap between the practising professional scientist and the student, especially with the rapid and exponential expansion of the scientific knowledge base. We discuss each of these challenges in turn and while acknowledging that there can be no easy or ready answers, attempt to outline some speculative, anecdotal solutions. These problems are of course interrelated, and a deep hard look at our pedagogical approaches to teaching life sciences followed by a significant revamp of our curriculum may be necessary to ensure that our graduates are competitive in today's economic and intellectual environment.

The scientific approach

In an editorial for the January 2009 issue of *Science*, its editor-in-chief Bruce Alberts (formerly the president of the National Academy of Sciences) lamented that a "vast number of adults fail to take a scientific approach to solving problems or making judgments based on evidence" (Alberts, 2009). These include college-educated adults, and he suggested that the situation arose because "science teachers failed to make it clear that science fundamentally depends on evidence that can be logically and independently verified; instead, they taught science as if it were a form of revealed truth from scientists" (Alberts, 2009, p. 5). Dr Alberts was of course referring to the situation as he sees it in the USA. However, this problem is rampant in other countries as well, many of which are dependent on a science and technology driven, knowledge-based economy. To put it simply, in their attempts to cover the syllabus within a prescribed time frame, college or undergraduate science teachers often teach only the facts, without delving into how factual knowledge can or should be acquired. Reciprocally, to do well in their exams, students familiarise themselves with only the facts and how to apply them, without bothering too much about how these facts come about and how to acquire more information beyond what is already known. Hence, some students who subsequently enter graduate school quickly discover their inadequacies in this regard and attempt to adjust their learning style along the way. Those who do not may go on being unenlightened, losing countless opportunities to exercise creative and innovative thinking (which they are indeed capable of) whilst being part of the workforce, and also deprive themselves the chance to enjoy the fruits of a lifelong education.

How do we deal with this problem given the constraints of time, large classes and the modular nature of undergraduate teaching? Also, given that fact learning is a necessary component of life sciences education, how do we also teach students how to ask questions and acquire answers using the scientific approach? An obvious way is to set aside a compulsory module that 'teaches' the scientific method and its practice. Such a module is available but unfortunately, not to the entire cohort of life sciences majors. The effectiveness of such a module in cultivating in our students a scientific approach towards knowledge enquiry needs to be assessed, and we urge that the assessment be carried out in a systematic manner soon. We would go a step further to suggest that such a module be made available to all science majors, particularly as one of the first-year bridging modules.

Within each module, attempts could be made to reduce fact learning, with a corresponding increase in enquiry- or problem-based learning. Depending on the subject matter, this is often easier said than done, for various reasons. One problem arises from the fact that our cohort includes students from diverse backgrounds. Students need a minimum amount of factual knowledge before they attempt any enquiry-based learning. Many students, burdened by the large number of modular credits they have to complete to graduate, may also find any extra effort required on their part to acquire knowledge beyond the 'normal' contact hours annoyingly demanding. It may reflect negatively on the instructor's feedback scores, and may potentially deter them from trying 'something different'. Despite such concerns, any attempt towards promoting enquiry- or problem-based learning should be encouraged.

Changing the mode of assessment for both students and instructors

Examination questions could also be structured in a way that focus on students' ability to solve problems and synthesise the knowledge they have acquired, rather than plain regurgitation of facts. One effective strategy is to introduce an "open book" component in the continuous assessment, or even the final exam (Vanderburgh, 2005). Wiggins (1990) stated that "assessment is authentic when we directly examine student performance on worthy intellectual tasks." Indeed, even questions for "closed book" exams should be designed to test students' ability to make use of the knowledge instead of their ability to throw back facts. Assessment for project work-based modules could also utilise some form of a rubrics system[1] (Tierne & Marielle, 2004) that specifically grades students based on their ability to conduct an independent scientific enquiry and not merely on whether they can execute a list of techniques in the laboratory. The change, in which student assessment rewards students who apply their minds to problem solving rather than for regurgitating facts, reinforces the idea that rote learning will not serve them well during their undergraduate studies and later in life.

Closely related to student assessment is student feedback. Feedback criteria should be modified to reflect the instructors's effort in developing students' thinking skills. This would provide support to instructors who step away from the easy task of merely transmitting information from textbooks.

These strategies are not novel, and most have been practised by individual instructors with varied results. What we urgently need, however, is the organised and systematic implementation of enquiry- or problem-based learning pedagogy in the teaching of life sciences.

Closing the gap between the practising scientist and the students

The knowledge gap between an instructor who is a practising scientist and the students can be immense, particularly in knowledge pertaining to the instructor's field of research. This knowledge gap can be obstructive in teaching and learning. A set of notes, diagrams, or verbal delivery style which may seem sufficiently clear from the instructor's perspective could be incomprehensible to some or understood by only a few in class. In advanced life sciences, this problem is not simply about the level of difficulty at which the material is pitched. The gap can also be due to the instructor's technical know-how and experience compared to the students. Acquiring knowledge in the life sciences requires consistent empirical experimentation and analysis. Contemporary life sciences experiments are sophisticated in both approach and the level of technology. The devil is in the details, and students who lack exposure to the practical aspects of scientific enquiry are impossibly handicapped in understanding, interpreting and learning from scientific findings or facts. Omitting such experimental details brings us back to the problem of learning facts without comprehension of how such knowledge is acquired, and how to assess scientific evidence or acquire further knowledge.

With the explosion of data and information in life sciences research, it is no longer realistic to expect students to appreciate the subject by merely offloading the information on them. A useful approach could be to draw their attention to the historical experiments that have led to key discoveries that shaped our ideas on life sciences. More importantly, highlighting the kinds of questions pioneer researchers asked that led them to the experiments and subsequently, the answers to their questions allow students to appreciate the process of scientific enquiry and may trigger their curiosity and interest in the subject. Getting students to think about the problems in biology and showing how early scientists solved key questions by inventing new techniques and methods will provide them with insight into the fundamentals of adopting the scientific approach.

An interesting point to this method is that one can start with fairly simple experiments performed by early researchers that often relied more on their ingenuity than sophisticated equipment. As such, students do not need much prior knowledge in laboratory techniques and methodology, especially for the introductory modules where their background knowledge of the subject matter may vary. The module's main outcomes should then be to enable students to:

(i) ask a reasonably important biological question which is testable (either in practice or as a thought experiment),

1. See Rubistar, *http://rubistar.4teachers.org/index.php?screen=NewRubric&section_id=9&PHPSESSID=1fb8123d13ffea48487631ca3951fcbcb#04*

(ii) come up with hypotheses that could potentially provide answers to the biological question and

(iii) design a series of experiments which could support or exclude their hypothesis.

Once they have been exposed to the basic concepts of the scientific approach, they may be more prepared to handle the facts presented to them. More importantly, the approach will serve as a basic skill for those who plan to pursue advanced courses in life sciences. By developing their thinking skills, students who go on to pursue careers in non-science related fields will also carry with them the attitude of critical thinking that would help them solve problems and make decisions effectively. However, some educators have found that although students resent learning and memorising facts, they may not necessarily be receptive to being taught how facts were discovered either (Wiley, 2009). Striking a good balance between the two modes of teaching may be the key.

In the context of our system, the Undergraduate Research Opportunities Programme in Science (UROPS) has offered interested students a chance to conduct guided research. Again, only a fraction of the student cohort have joined UROPS. Given the tremendous learning opportunities, particularly in terms of knowledge enquiry, which a UROPS stint could offer, it may be time to make UROPS a compulsory module for all life sciences majors, or as a prerequisite to reading Honours. However, there are two major logistic obstacles to resolve. The first pertains to students' workload. The total number of modular credits required for graduation would need to be reduced to allow them a relatively 'free' semester for UROPS research. The second and more difficult problem concerns the availability of laboratory supervisors, laboratory bench spaces and related resources to cater for the large number of students. At the moment there is no simple resolution for this, unless federal research funding agencies (e.g. A*STAR and the National Research Foundation) could be convinced that serious and systematic undergraduate research training could go a long way towards solving the problem of expert manpower shortage and cultivating a skilled workforce, which would be essential for a competitive economy in generations to come.

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Small Group Teaching—Get and Give 100% the 'Old-fashioned' Way: Perspectives from the Pathology Classroom

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Small group teaching is a great opportunity to interact with students, exchange ideas and impart knowledge. With large student cohorts being the norm in the medical faculty (>250 students), we often face a new group each time. Thus, it becomes a challenge to establish a quick rapport and impart sound concepts over an hour long session. Although advances in instructional technology have significantly widened the repertoire of available teaching tools, in this article I will highlight some 'old-fashioned', low-tech methods requiring only a willing tutor and the whiteboard, that have served me well over the years.

In tackling the dual challenges of consolidating concepts and building rapport, I follow two basic principles:

- What to teach: Create a solid lesson outline
- How to teach it well: Encourage class participation

What to teach: Create a solid lesson outline

Step 1: Revise

Lesson content is entirely dependent on the tutor—we must know our stuff. Spending a quick half hour reading a basic text for a fact-heavy topic enables one to select the important parts and plan a quick topic summary.

Step 2: Prepare a topic summary

Begin the lesson with a 10-minute topic summary. Despite having attended the lecture recently, students may not have assimilated the facts or even fully understood the topic. The topic summary will help them crystalise their ideas about the fundamental concepts they learnt, and they can build on this framework when they do their own revision.

To do this, simplify and contextualise the facts. In short, go for 'the big picture'. The following are some ways to simplify the facts:

- Break the topic into simple, logical parts that the students can work out for themselves. For example, when I teach them about neoplasia (tumours), I ask them questions such as, "What is a simple and clinically useful way to classify neoplasms?" Students usually reply "Benign vs malignant." One can continue the lesson from here.
- Use mind maps. Delve successively deeper into each arm of the map while keeping the big picture in mind.
- Avoid providing too much detail.

To contextualise the facts, one should:

- Keep it interesting and relevant.
- Demonstrate how the topic relates to real life. For instance, how does one teach students the dry, isolated topic of cell adaptation? One way is to use the example of an athlete with huge muscles (hypertrophy) to spur their imagination, whereupon they can extrapolate the changes expected at a cellular level.
- Help students draw direct links to their own experiences. For example, when I teach them about inflammation, I ask them to recall their experience of getting a mosquito bite—why does it swell, become red and painful? Get them excited about real life occurrences as they try to work out the basic science behind them.

How to teach it well: Encourage class participation

Class participation is based on the degree of rapport established between students and the tutor. Again, I employ two simple tools: empathy and humour.

Empathy

Students can sense indifference in a tutor. We need to empathise with their situation, whether it is information overload, insecurity or fear of being embarrassed in front their peers. When they realise we understand their psyche, it makes us appear approachable and non-threatening. How do we do this?

- Listen. Ask them how they are doing and show genuine concern.
- Reassure. State firmly that there is no such thing as a "stupid" question or answer. Tell them it is better to make a mistake now than when they treat actual patients, where serious consequences may arise if they misdiagnose. If that does not work, ask them if they would rather get it wrong during a tutorial or the exam, which should convince them to speak up!

Humour

Encourage laughter, which captures their attention and builds rapport. Laugh not *at* the students but *with* them.

Another useful tip is to get one student to call on another to answer the next question. This may elicit some 'killer' stares which always gets a good laugh and breaks the tension.

With a little imagination, it is easy to find humorous examples to illustrate teaching points.

In conclusion, in teaching as with everything else, the more we give, the more we get in return. Applying these simple tools maximises the positive interaction between tutor and student. A responsive, actively thinking and questioning small group is one of the greatest pleasures a passionate tutor could experience. ■

Two Strategies to Facilitate Active Learning in Large Classes

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Strategies that facilitate active learning are instructional activities that "involve students doing things and thinking about what they are doing" (Bonwell & Eison, 1991). Various strategies and methods that claim to aid active learning have been documented in the literature (Silberman, 1996). However, due the physical constraints of a lecture theatre, many of these suggested approaches are either difficult or impossible to implement in a large class setting.

Nevertheless, I have found that modifying the traditional lecture method using simple approaches that do not deviate very much from conventional classroom methods have been well received by students. These strategies are interwoven with and incorporated into the typical 2-hour lecture in NUS.

One of the more popular strategies I have tried is the bingo-like game for the topic "Energy and Life" under the module LSM1301 "General Biology". LSM1301 is designed for students with no prior background in Biology and had an enrolment of 577 students in Semester 1, Academic Year 2008/2009. Instead of utilising it for reviewing purposes as suggested by Silberman (1996), it was used to introduce the class to the terminologies that would be covered in the topic. A five-by-five matrix table of 24 blank cells with the middle cell labelled "FREE", similar to Figure 1, would be distributed to each student at the start of the class.

		FREE		

Figure 1. Sample of the matrix table used in the game

The students would then be shown a list of 24 terms and instructed to randomly fill each of the table's blank cells with a different term from the list. The students were also told that they could use each term only once. Once the students had completed their task, the *definitions* of the terms would be read aloud and they would cross out the terms on their tables that they thought would match the definitions that were called out.

The first student to cross out five cells in a row either horizontally or vertically would raise his or her hand and the game would be temporarily stopped. The crossed-out terms would then be checked to see if they were correct. If the terms were incorrectly crossed-out, the game would resume with more definitions being read out until the next student raises his or her hand. If the five crossed-out cells were correct, the student would be declared the winner and he or she would be rewarded with either candies or chocolates. After the game, each of the terms and their correct definitions would be reviewed.

The choice of giving out something sweet as a prize serves as an illustrative tool to connect glucose to cellular respiration, which is the subject matter of "Life and Energy". The game also reminds students to come to the class prepared—a trait that seems to be lacking among most of them. Furthermore, when the terms appear later during the lecture, students would have already seen the them and I would need less time to explain them.

Another well received strategy is the use of crossword puzzles, which I had tried out in both LSM1301 "General Biology" and LSM1401 "Fundamentals of Biochemistry". Unlike other biochemistry modules, students enroling in LSM1401 do not need to have a pass in A-level Biology. Thus the class is often made up of a heterogeneous mix of students, including those who have read A-level Biology. Just like LSM1301, LSM1401 has a relatively large enrolment and in Semester 2, Academic Year 2008/2009, there were 420 students in the class.

Unlike the bingo-like game, crossword puzzles were utilised at the end of a series of related topics to help students review the terminologies used. The crossword puzzles (see Figure 2 for an example), were distributed towards the end of the class and students were given sufficient time to complete them.

It is probably not critical but lecturers could decide if the first student who correctly completes the puzzle should be rewarded. There were occasions where I gave out a reward and times where I did not. Although the responses were not significantly different in both cases, students generally love freebies. What is important, though, is to allocate sufficient time to provide and explain the solution to the class.

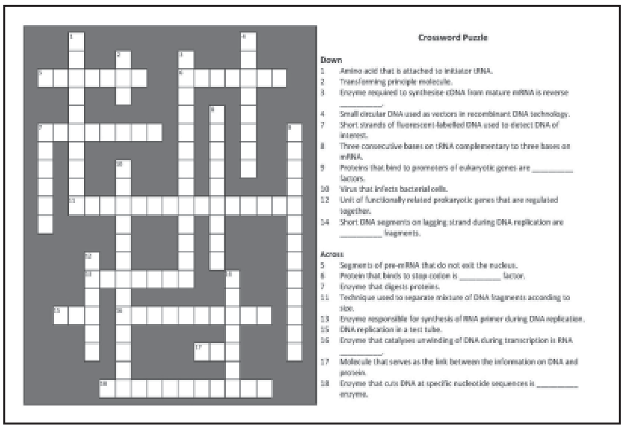

Figure 2. Sample of the crossword puzzle used in LSM1301. A similar crossword puzzle was used in LSM1401

Did the bingo-like game and crossword puzzle facilitate active learning and enhance the effectiveness of the teaching process? The following are samples of comments from student feedback on the use of these strategies:

- "[He] supplements the lecture notes by providing…a crossword puzzle and a bingo sheet, which enhances learning as it is something out of the norm, allowing students to learn terms and facts in a new manner…"
- "…very good that he used the game BINGO in one of the class to make the lecture more fun and interesting and also facilitate our understanding in the topics…"

- "…crossword puzzle and 'bingo' game for us to know our terms better which I think was very useful…"
- "…well engaged through various activities such as the crossword puzzle…to reinforce… or encourage reading ahead despite the large lecture group…"

Both strategies did not incur considerable cost and did not result in major changes to the traditional lecture method. However, the strategies resulted in a significant change in the learning process as perceived by the students.

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Using Short Stories as an Instructional Tool for Teaching Human Anatomy in the Classroom

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The study of human anatomy is fundamental to the learning of medicine. Indeed, *Gray's Anatomy*, a classic anatomy textbook currently in its 40^{th} edition (Standring, 2008), is held in the highest esteem in a doctor's education and ranked as essential reading beside the Bible and the works of Shakespeare (Richardson, 2008). The anatomy student is required to examine all the tissues and organs in the body, understand the relationships among these structures and apply the knowledge to clinical practice. Given the complexity of the human body and limited curricular time, this means that students have to master a vast amount of information within the first year of medical school. To help students cope with their learning tasks, many anatomy educators stress on the importance of understanding basic principles, and advise students against relying solely on rote memorisation. Unfortunately, although most students are able to grasp these principles during classes, a significant number of them fail to retain, internalise or apply the knowledge in their studies. The use of short stories as an instructional tool in classroom teaching may help alleviate some of these problems.

Short stories have been used for thousands of years as a means of education, knowledge transfer and entertainment. Without doubt, many of us can readily recall *The tortoise and the hare* and other Aesop's fables, which have brought joy to our childhood and helped shape our values. Writers such as Gladwell (2008), Levitt and Dubner (2005), and Brafman and Brafman (2008) made extensive use of short stories and case studies in their books to present and argue their hypotheses. Often, these stories are firmly lodged in our minds regardless of whether we agree or disagree with the authors' ideas.

A well-crafted short story easily captures the audience's attention. As the entire tale can be told within a few minutes, its message can be rapidly and effectively conveyed to the student before he gets distracted by the next message that appears on his mobile phone or other interruptions in class. Furthermore, stories facilitate contextual understanding of the encoded information, and provide a non-threatening means to encourage learning.

In formulating short stories for teaching anatomical principles and facts, it is important to bear in mind that the human element is crucial for bringing stories to life and making the lesson stick in the learner's mind. As the subject matter is life itself, anatomy is in an advantageous position with regard to the use of stories for learning. Consciously or otherwise, anatomical principles are present in everything that we do—from the simple act of touching a blade of grass to more complex activities such as scoring the goal in a soccer game. To ensure its effectiveness, each story should have the main learning objective of a lesson as its central theme. Embedding multiple learning tasks into a single short story runs the risk of scattering the learner's attention and confusing him with too much information. In picking scenarios for our stories, we should select those with which our students are familiar. Thus, while scenes from medical drama series such as *Grey's Anatomy* or *House* might readily connect with our students, those from *Chicago Hope* or other television programmes in the distant past are likely to elicit only blank faces. In general, the presence of a puzzle that needs to be solved or an unexpected twist in the events being unfolded in the story tends to engage the learner much better than a straightforward narrative.

The ulnar paradox is a well known clinical scenario that can easily be incorporated into a short story for a lesson where the learning goal is to understand the innervation of muscles that control finger movements in the hand. The scene is easily set up by the lecturer simulating the claw deformity of the ring and little fingers, or by showing a photograph of a patient afflicted with this condition. In the ulnar paradox, a severe, proximal damage to the ulnar nerve leads to the paralysis of a larger number of muscles but a milder claw deformity compared with a more distal occurrence of nerve damage. This apparent paradox forms the unexpected twist or puzzle in the story, and the student is thereby challenged to apply his anatomical knowledge to come up with an appropriate explanation.

Short stories provide a good avenue for exposing students to clinical problems. This is particularly important to first year medical students as they have limited patient contact. In addition, they serve as an excellent introduction to problem-based learning sessions, which provide opportunities for in-depth dissection and analysis of more complex medical problems that possess multiple learning points straddling various disciplines.

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Customising Continuous Assessment Exercises

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Continuous assessments such as essays, quizzes, individual and/or group projects constitute an important part of university courses. Designing an effective continuous assessment could supplement and reinforce classroom teaching, and sustain students' interest in the subject.

A group project involves solving an integrated set of problems. The project can be demanding in scope and time requirement. Division of labour and teamwork are necessary to ensure that the project can be completed on time. In all group projects, it was not uncommon to hear feedback about free-riders and students' inability to see the 'big picture' particularly when work is divided among the group. Due to time constraint, some members could focus only on his/her assigned portion of the project and students were left with little time to share inputs and discuss key issues in the process.

In Semester 2, Academic Year 2008/2009, I was assigned to teach a General Education Module, GEM2013 "Real Estate Finance". Instead of combining multiple issues into a single project, I took the opportunity to test the effectiveness of breaking an integrated project into small but related parts. Students were given the assignment in the middle of the semester and had to complete the project independently within a tight deadline.

In order to allow progressive learning, I designed a 3-part project on real estate finance centred on a young couple planning to purchase their matrimonial home—a four-room HDB flat located in Fernvalle Road, Sengkang. The three parts of the project were structured such that students are able to apply concepts they have learnt from lectures progressively and incrementally in providing financial advice to the couple. Table 1 provides a summary of the case study.

In the process of working on the project, students were required to survey various commercial bank loans and evaluate a selected loan option for the couple. For learning purposes, students were also allowed to choose a HDB concessionary loan, which is technically less complex for analysis. In parts II and III, simulated long-term interest rates were given (see Figure 1), and students were required to peg their interest rates to the simulated rates if adjustable rate mortgages were used in the earlier analysis. Each part of the project was to be completed in two weeks. I commented on students' work at each stage of the project so that they could revise their assumptions before starting on subsequent parts of the project.

The project structure gives students flexibility in applying real estate financing concepts incrementally and progressively, and also tested their willingness and readiness to take on more challenges by choosing more complex mortgage options in the analysis.

While some student felt that the freedom to set the scenario injected realism into the case, there were difficulties in defining the scope of the problem. Defining the assumptions and scenarios for the case required students to spend more time and effort on fact finding and ground research which as one student commented: "exposed [us] to a steeper learning curve where we have to conduct research and serious preparation in order to come up with a viable solution." Another student said: "I had to spend more time to understand the scenario and do some research on what is relevant and what is not relevant."

Some students liked the latitude they had in defining the problem: "it does force us to think, sometimes creatively…This is in contrast to clearly defined problems in which everyone does the same thing." Others felt uncomfortable with the problem's open-ended nature: "I was unsure if my assumptions were appropriate, or if my work was good enough and able to meet the project requirements." Another concern shared by many students was how the project would be graded because of variations in complexity and difficulty levels in the project.

Table 1. Timeline and development of case study

Project	Start Date	Due Date	Project requirement
Part I	5 Feb 2009 (Week 4)	19 Feb 2009 (Week 6)	Part I required students to evaluate a real estate financing plan for the young couple. Students were given different assumptions (e.g. loan to value ratio and term to maturity) to work on.
Part II	5 Mar 2009 (Week 7)	12 Mar 2009 (Week 8)	Part II required students to advise the couple on a decision to refinance their mortgage loan (in Part I) after five years.
Part III	26 Mar 2009 (Week 10)	13 Apr 2009 (Week 12)	Part III moves the time forward by another five years. The couple is deciding whether to sell their existing HDB property and upgrade to a private condominium. In this part, students are required to analyse the full payment of mortgage, and also assess the availability of cash for the purchase of the private condominium.

Dividing the project into three small but related parts also received mixed responses from students. While I managed to incorporate incremental and progressive learning into the course, as one student said: "they help enhance the learning process as each small part of the project can be related back to the corresponding lecture topics", there were others who were frustrated in having to revise project assumptions and abort some earlier work to align with information that was realised in stages as the project progressed.

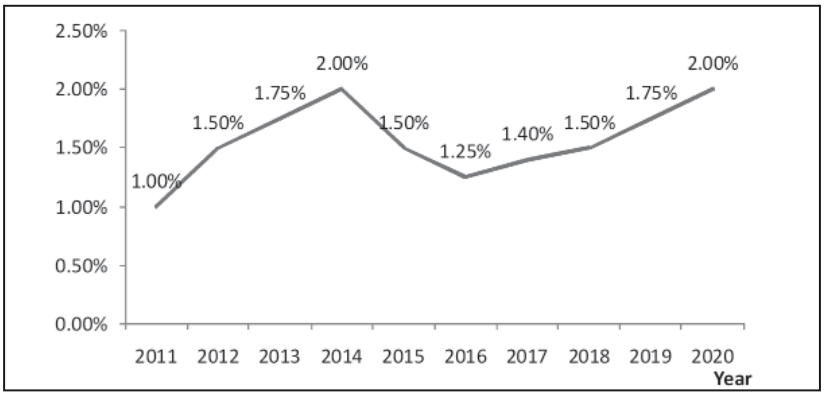

Figure 1. Simulated long-term interest rates

Many students suggested that the case information for the whole project could be given upfront though they are required to complete each part in stages. This could reduce redundant work as the project progresses, but it will not be able to simulate how information changes in a real life scenario. One way to improve the learning process will be to provide more detailed interim comments. Others also suggested that by sharing interim results of selected cases and allowing time for discussion in class could promote more interactive learning.

The progressive and customised assessment exercises were time consuming, but this process gives students the flexibility to set different scenarios and derive solutions to problems as opposed to solving problems based on a predefined set of assumptions. ■

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The Centre for Development of Teaching and Learning (CDTL) engages in a wide range of activities to promote good teaching and learning at the National University of Singapore, including professional development, teaching and learning support, research on educational issues, and instructional design and development.

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