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In the last issue of ***CDTL Brief***, we presented to you the first of a two-part discussion on **IT in Education Today**. In this second part of the discussion, we feature reports on some of the current uses of IT for teaching and assessment in NUS and Ngee Ann Polytechnic, and guidelines on the facilitation of online discussion forums.

A New Paradigm in Teaching Computer Science

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Introduction

Web-based learning is in vogue.[1] Proliferation of internet resources and the advent of web technologies have encouraged a paradigm shift[2] towards a more dynamic, web-based, hypermedia-oriented, and platform-independent environment, allowing many ways in which internet tools may be employed to enhance learning[3]. Riding on this trend, NUS launched the Global Campus concept in July 1998. Some 7,000 Plug and Play (PnP) points have since been installed across campus, with an attractive loan scheme made available to students to purchase notebook computers for use in selected modules and instruction for staff to upload their course materials on the Internet.

This article is based on the author's personal experiences in employing some popular IT tools in his teaching of two Computer Science modules: CS1101C (Programming Methodology in C) <http://www.comp.nus.edu.sg/~cs1101c> and CS1103 (Digital Logic Design) <http://www.comp.nus.edu.sg/~cs1103>.

Email, Electronic Submission of Assignments and Newsgroups

The ubiquitous email system has become an essential means of communication. A course mailing list can be easily created and maintained. Via email, staff can disseminate urgent announcements and students may send in their queries. In some institutions, an email handler is developed to maintain an archive of these queries and their responses.[4]

Email may also be used for electronic submission of assignments. In CS1101 and CS1101C, an electronic submission programme written in shell scripts and C is used for students' submission of programming assignments. Students' programmes are stored in depository directories, which are made accessible to the tutors for grading.

The electronic bulletin board, or BBS, is a convenient forum for discussion. Students can post messages into a newsgroup and queries are promptly read and responded to by others who can offer help. The newsgroup is a good means to supplement the course, providing the students with an informal channel to exchange information. Although messages on BBS expire after a certain period of time, lecturers may wish to save significant postings, reorganise them and put them on the course website.

Web-Based Courseware

Course websites can be uploaded on the Web. Lecturers can tailor the design of their webpages to suit the nature of their courses and their personal preferences. The NUS Integrated Virtual Learning Environment (IVLE) <*http://ivle.nus.edu.sg*> is a platform for creating, maintaining and viewing course webpages and related courseware. It also provides the IVLE Workspace for staff to create course outlines, detailed courseware and other facilities.

Course websites offer great convenience to both staff and students. Information can be disseminated and updated quickly, without having to rely on physical

meetings. This has become more crucial as the introduction of cross-faculty modules by the University means that it has also become more difficult in finding a common slot to meet all students taking the same module. On the average, students on the CS1101C and CS1103 courses access the course websites about 1.2 times a day.

Java and Animated Algorithms

In a programming and algorithm course such as CS1101C, animated algorithms have been shown to have positive effects on enhancing students' understanding, as they can watch how the algorithms work. Some systems even allow students to set the parameters themselves. X-window Transition-based ANimation generatiOn (XTANGO)[5] is one such algorithm animation system for creating graphical illustrations of programmes and algorithms. Recently, Java applet has become a popular choice. However, it is time-consuming to develop such visualisation tools. Interested readers may check out the Educational Technology research at the Graphics, Visualization and Usability Center (GVU) at the College of Computing <*http://www.cc.gatech.edu/gvu/edtech/*>. For a simpler alternative, Microsoft© PowerPoint allows the inclusion of some simple animations.

Online Quizzes

With the growing trend to reduce the weightage of the final examination, the importance of continual assessment has been raised. More and more modules in the School of Computing now have a weightage of 40% (a few even less) on the final examination, with the other 60% (or more) contributed by continual assessments: tests, quizzes, projects, etc. Some courses, such as CS1101C and CS1103, assign regular cgi-scripted online quizzes that comprise multiple-choice questions. The CS1101C and CS1103 websites contain such self-administered online quizzes and scores are immediately reported.

These self-administered quizzes are very popular among students as they appreciate the instant feedback such quizzes provide. Very often, lecturers want to ensure that the students know their basics well, but time constraints put us in a difficult position. The provision of such quizzes extends learning activity outside class hours, where students can evaluate their lower-level skills such as knowledge and comprehension on their own. Higher-level skills such as application and analysis can then be tested in other formal tests. By setting quizzes, lecturers can also gradually build up a question bank.

Some modules, such as CS1101, take a step further and administer graded quizzes through the Web. Naturally, such quizzes require tighter security control and checks such as a time-stamp to register the time at which the quiz is attempted.

Lecture-On-Demand (LOD)

At the start of Semester Two of the academic year 1998–9, three modules—CS1102, CS1103, and CS1301—were mounted on the Lecture-on-Demand (LoD) front <*http://www-lod.comp.nus.edu.sg/*>, and since then, IT1001 and IT1102 have joined in. LoD is a strategic initiative of the School of Computing to further harness the power of information technology. Lecturers of these three modules prepare their course material using appropriate presentation software and record their lecture slides and monologues into Lotus© ScreenCam files, which are then played back through a web browser, or CD-ROMs. Students may choose to view (and listen to) these lectures at their own leisure, freeing themselves of any time or physical barrier. Recitations are conducted in place of live lectures, in a 1:2 ratio in terms of allotted time. Recitation groups are also of a smaller size of fewer than 50 students per group. In this way, students benefit from greater interaction with the recitor, made possible by the smaller class size.

Some clarification is in order here, as LoD might be erroneously associated with distance learning or self-study. A misconception held by some students is that LoD wipes out human interaction from the teaching process. This is not true. Considering that our School's enrolment is in the region of over 500 students per year, there is not much room for interaction during lectures in the first place. Recitations, tutorials, consultation hours, and email exist to provide the channels for interaction and the personal touch at all levels, ranging from face-to-face communication, to remote electronic exchanges and unidirectional broadcasts.

Conclusion

No single method is perfect and able to serve all our needs. Our challenge is to continually explore existing technologies, keep a lookout for new ones, and to find an optimal mix to meet the objectives of providing a more dynamic and stimulating learning experience for our students. However, in general there are still many limitations and glitches to overcome. These technologies are relatively new, and still evolving. Speed and bandwidth are a major concern. Initial cost is high, and that includes not only the infrastructure required to support these facilities, but also the amount of work the course instructors have to put in, which can be daunting. Continual support from the University, both in terms of hardware and expertise, is essential in making this a success.

Despite the benefits of these mechanisms, we have to remind ourselves that no amount of fanciful gadgets can hide or make up for poor content, or the lack of organisation. The use of tools does not render the seven deadly sins of teaching[6]—arrogance, dullness, rigidity, insensitivity, vanity, self-indulgence, and hypocrisy—any less relevant. Quite the contrary, the proliferation of these

attractive tools, which are made more convenient and easy to use by the day, might make us even more susceptible to committing these sins, if we lose our bearings and over-rely on technology at the expense of the wisdom of good teaching.

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Using **IT** for Tutoring and Assessment at Ngee Ann Polytechnic

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Introduction

The use of IT to aid learning and assessment has been a continuing quest for staff at Ngee Ann Polytechnic. In the last fifteen years, there have been many initiatives and much has been learnt. In 1997, the Polytechnic piloted a Computerized Tutoring and Assessment (CTA) programme to use IT to enhance learning. Its online Computer Assisted Tutoring (CATu) and Computer Assisted Testing (CATe) facilities strive to achieve greater productivity for all. The basic approach we have taken is to hand over those tasks that can be automated to the computers. This article presents some of the rationale behind the programme.

Why Use IT for Tutoring?

Traditional teaching in the classroom often involves the use of tutorials to assist students in practising what they have learnt in the lectures. However, it is time consuming for lecturers concerned to mark tutorial work due to the large number of students in each module. To use tutorial hours to help students tackle problems that they cannot solve is also an issue when students have yet to attempt the tutorial questions given out previously. Little learning can take place if students resort to copying solutions from one another. Teaching on subsequent topics becomes harder when students fall behind in their tutorial work.

Moreover, it is hard for lecturers to reach out to weaker students or help those with specific learning problems in a group of 20 or more students and all the tutorial questions must also be covered. At the same time, students who have understood their work well and completed their tutorials early are still required to attend tutorial classes because of the compulsory attendance system.

In using CATu, many of the above issues can be tackled. First, we automate tutorial question items by randomising the values of the parameters in the questions so that each student will receive similar questions but with different values for each parameter. In this way, students have to work on their own questions because the answers are different. At the very least, they will need to learn how to solve the problems as well as the formulae needed to solve the problems. Peer tutoring is encouraged. We also ensure there is sufficient feedback in the tutoring items to assist the students in solving a problem.

Next, we place the tutorial papers on the Internet. In this way, the students are presented with their tutorials right from the first day of their course. They can access these from anywhere and in their own time before each of the due dates.

Third, since data is captured, computed and stored in the tutoring server, lecturers can monitor students' progress, identify the question items that pose difficulties, and provide necessary guidance to see that students are on schedule, thus ensuring progressive learning. In addition, students who have completed their tutorials can attend to other learning activities and lecturers can coach smaller groups of students who need further help. This leads to productive use of time for all.

Why Use IT for Assessment?

In traditional teaching, tests or assessments at mid-term are often used as an instrument for lecturers to check on the progress of students. Often, the paper test approach requires much of the lecturers' time in marking during which they will still need to continue with teaching. The marking, checking, compilation of test reports, and the announcement of results usually take about two to three weeks. At times, there is no feedback available to students until the end of the semester or just before the examinations. Meanwhile, students are anxious to know their results and where they have gone wrong in the tests. Any review, consolidation of students' knowledge and skills, or rectification can only be done after the results are officially released.

CATe is used to solve some of the above problems. We automate whatever question items that can be tested using the computer. We make further use of the same approach for the automating of tutorial questions. Hence, students are given sets of questions drawn from randomised question pools that also make use of changing question parameters to prevent cheating. These test items also carry relevant feedback that is included by the lecturers.

Students receive their test results while lecturers receive their students' performance reports immediately after each test. Reviews can be conducted to allow students to find out where they have gone wrong. They can challenge the computerised marking by submitting a feedback form. In this way, learning takes place and any misconception can be quickly rectified.

In some cases, students are allowed a chance to take a second test (a newly set one) to better their marks when they score below a stipulated class mark. If they can perform better than the class mark in the second attempt, they will be awarded the class mark. A re-test is necessary for those who score below 50% on a test.

In the above ways, CATe is used both as a support for learning, as well as a performance measurement tool. It also leads to better use of time for all concerned and a system for continual improvement in test and item design for lecturers.

Conclusion

The pilot programme in 1997 has led to a full-scale implementation of CTA at the Polytechnic in 1998. Lecturers whose modules can make use of this programme have been encouraged to take part in the implementation. Today, there are some 90 modules using CATu and some 200 modules using CATe. Over the years, the Polytechnic has invested much on infrastructure to support the programme. Both students and lecturers continue to make use of CATu and CATe in learning and assessment. As part of our continual improvement efforts, the Polytechnic is also currently studying other methods for assisting student learning and better measurement of performance. ■

Maximising the Potential of Computer Mediated Discussion: Guidelines for Facilitation

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Online discussion forums, or Computer Mediated Discussions (CMD), are popular with lecturers wishing to use IT to enhance the quality of student learning. At NUS, statistics show that the online discussion forum is one of the most utilised tools in the Integrated Virtual Learning Environment (IVLE). However, one need not look very hard to see many struggling or abandoned forums. Because how the teacher mediates CMD affects the way students participate and the quality of discussion (Ahern 1992), this article aims to help faculty maximise the potential of CMD by offering some guidelines for facilitating online discussion forums drawn from research on CMD:

1. Have a good reason for using CMD

Focus participants by being clear about why you are using CMD. Besides making it 'convenient' and 'easier' for students to communicate collaboratively (Kitchen & McDougall 1999, Hudson 2000), CMD can promote meta-cognition and

foster new ways of thinking and processing ideas (Johanyak 1997, Olaniran 1996, Minch 1995, Gil & Quinones 1999). CMD also helps students develop language abilities (Beauvois 1998) and generate a wide range of views (Sommers 1997).

At NUS, various faculty members have used CMD in different ways[1]:

- To allow students to submit a summary of their tutorial readings so that everyone can see what others think before tutorial discussions.
- As a forum for answering any course-related questions students may have.
- To get students to discuss and evaluate one another's project work.
- As part of an online distance-learning course in which the CMD is the key interactive component for students to raise questions and discuss problems.

2. Do not assume everyone is familiar with CMDs

Students may not participate in CMDs because they find the CMD software difficult to use (Lee 2000), or they do not know how to log on to the CMD or are unable to access it because of limited computing resources (Fishman 1999). Lee (2000) found that students when faced with technical problems suffered 'cognitive overload', hence distracting them from the CMD's intended purpose. In addition, participants may also not know what is expected of them once they have logged on to the CMD. Hence, English (1997) suggests giving students clear instructions on how to utilise CMDs (i.e. the technical aspects of how to log on and some guidance on how to participate and learn in a CMD environment).

3. Create specific tasks for students to work through collaboratively

Motivate and guide students in their CMD participation by setting them tasks [e.g. debates, simulations, games, role-plays, case studies, transcript-based assignments, brainstorming, delphi-techniques, nominal group techniques, and projects (Paulsen 1998)]. Tasks that stimulate online discussion are particularly useful if the teacher and students are new to CMD and need some structure to establish a culture of discussing online.

Some researchers have argued that ideally CMD tasks should be collaborative in nature because they believe learning is a process of social construction [i.e. learning is not a passive process in which a teacher imparts knowledge to a learner, but an active process for the learner, where meaning is negotiated with peers and others, drawing upon prior prepositional and procedural knowledge in making sense of new information (Evans & Butler 1995)]. In a university setting, the real value of collaborative learning is getting students to work with each other, instead of depending on teacher-student interaction alone. Collaborative learning can lead to deeper learning by promoting rich and complex cognitive processes such as working through conflict/disagreement, developing alternative proposals and self-explanation, internalising and appropriating ideas, sharing cognitive load, participating in mutual regulation, and finding one's social grounding (Dillenbourg 1999).

4. Participate in the discussion, but sparingly

Lee (2000) established that students disliked it when tutors were not directly involved in the discussion. Yet Veerman (2000) found that when a tutor challenged and countered a student's opinion, it immediately ended the discussion. Thus by participating sparingly, facilitators can avoid undermining the discussion. In fact, moderators who accept a more facilitative role help students take greater responsibility for their own learning (LaGrandeur 1997).

5. Ask questions or make comments to help students understand/learn in a deep fashion

The key ingredient that determines the success of a CMD is the teacher's facilitation skills in being able to assist students to learn without spoon-feeding or abandoning them. If CMD is a collaborative tool for students to learn deeply, then facilitation should help students move through the different phases involved in the social construction of knowledge. These phases, based on the work by Gunawardena et al. (1998) on interaction analysis, are:

i) Sharing/Comparing of Information. Students offer statements of observation/opinion/agreement or ask and answer questions to clarify details of statements/definitions/descriptions.

ii) Discovering and exploring dissonance/inconsistency among ideas. Students identify and state areas of disagreement. This is the operation at the group level of cognitive dissonance [i.e. an inconsistency between a new observation and the learner's existing framework of knowledge and thinking skills (Festinger 1957)].

iii) Negotiating the meaning/co-construction of knowledge. Students negotiate/clarify the shared meaning of terms and assign relative weights to different types of argument. Proposal and negotiation of new statements embodying compromise should begin to appear.

iv) Testing and modifying proposed synthesis/co-construction. Students test the proposed synthesis against 'received fact' as shared by the participants and/or their culture, existing cognitive schema, personal experience, formal data, and contradictory testimony in the literature.

v) Specifying agreement statements/applications of newly-constructed meaning. Students form statements that summarise agreement(s) and examples of the applications of new knowledge, as well as meta-cognitive statements that illustrate an understanding of how they have constructed their knowledge and ways in which their thinking (cognitive schema) has changed.

Phases (i) and (ii) typify the level of discussion in many CMDs. While in some instances the latter, and more

[1] *A two-part CDTL workshop on 'Maximising the Potential of Online Discussions for Learning' was held on 1 February and 5 April 2001. During the interim between each workshop, the 18 faculty participants were invited to participate in an online discussions, the experience of which was reviewed on 5 April.*

complex, phases may be achieved by other means (e.g. face-to-face discussion, project work, group study), Phases (iii) to (v) are largely absent in CMD because the associated thinking is not explicitly encouraged enough by pro-active facilitation. To help students move through the different phases, the facilitator would have to ask different types of questions and/or prompt reflection at appropriate times.

For example, after posting a discussion question and allowing students to respond, a facilitator could ask: "How do the various responses amongst class members differ? Is there any way of reconciling opposing points of view?" Next, the facilitator could encourage students to form a hypothesis based upon what the group has discussed and to test this hypothesis against what experts have said in the literature. Then, invite students to reflect upon what the class has learnt as a whole. Finally the facilitator might ask students to share how they feel about the CMD process and describe how the discussion has changed the way they think about the subject matter.

6. Relate CMD to classroom discussion and vice versa

A lot of studies on the effectiveness of CMD have compared this mode with face-to-face classroom discussion. Some studies, while admitting to differences in the way the discussion is carried out (e.g. asynchronous as opposed to synchronous), have contended there is no major difference in learning outcomes based on the medium of discussion (Hall 1999).

Other studies have argued that CMD does lead to better student outcomes. Scovell (1991) found students using CMD scored higher on writing and reading tests. Scott (1993) alleged that students using CMD were more considered in their responses, productive in accomplishing task objectives, and more uniform in their participation. Phillips & Santoro (1989) found courses with CMD received higher students satisfaction ratings. Mahesh & McIsaac (1999) suggested that students who used CMD became more committed to the course and established closer student-teacher interaction; however, this depended upon the quality of the teacher and the time he/she was willing to put into CMD.

Other studies that looked at the effect of combining CMD and face-to-face discussion suggest that the two mediums help facilitate different types of learning outcomes. Althaus (1997) established that students who had mixed-mode courses earned better grades than those doing either by itself. Veerman (2000) found that while CMD was effective in getting students to conceptualise and be task-orientated, it was less effective than face-to-face settings in helping students finish tasks. Marttunen & Laurinen (1999) showed that CMD helped to enhance text-based argumentation skills and face-to-face discussions were better at developing counter-argumentation.

Although adopting both mediums of discussion in a university course can help students develop a wide range of skills and encourage them to ponder about the subject matter beyond lectures/tutorials, this method comes at a cost. Tolley (2000) revealed how one lecturer on average spent at least four hours a week moderating CMDs on top of a full teaching load. However if one is able to bear this cost by possibly distributing the load amongst colleagues/tutors/students, or offsetting it by reducing some portion of face-to-face contact, then the focus should be upon how can one help students to commit to both mediums? Because of the established lecture-tutorial structure of higher education, students generally value face-to-face contact and equate what is important by what is said in the classroom. Failure to address issues that have emerged from the CMD in the classroom or vice versa suggests to students that the CMD is unimportant and is simply a 'nice-if-one-has-time' appendage to the course. So to help integrate the online and face-to-face mediums, lecturers could develop tasks where some elements are completed online and others during face-to-face contact.

7. Give students strategies for 'repairing conversations'

Veerman (2000) reports how CMD lacks the physical and physiological cues (e.g. appearance, intonation, eye contact, group identity) that are critical in repairing any communication breakdowns in traditional collaborative learning environment (Johnson et al. 1976). To help students overcome miscommunications in CMD, Winiecki et al. (1998) suggests the following strategies:

- Get students to summarise the argument/thread so far, specifying specifically who has said what to who and when did they say it.
- Cut and paste relevant or strategic parts ("snips") of previous emails.
- Encourage students to clarify whether they have understood what someone else has said.

One additional suggestion is to encourage students to express feelings through textual smilies (O'Grady 2001).

8. Motivate by having a good activity/task and by pointing out the benefits of CMD

Other possible reasons why students fail to participate in CMD include:

- Students do not want to appear ignorant (Englebardt 2001) and are concerned about the permanency of postings (Akers 2001).
- Students feel like they are talking to 'photo-electric walls' (Sproull et al. 1984).
- Students feel that their peers do not respond in the same spirit as they do (Scardemalia et al. 1992).
- Students find CMDs as too much effort or a chore (Newman et al. 1995; Clark & Brennan 1991).
- Students have no reason for saying anything, i.e. what they want to say has already said by someone else (McKendree et al. 1998).

Such barriers are not insurmountable and suggest that with some careful planning, students can be motivated to participate. For example, a teacher can divide a large discussion group into smaller groups, assign a student in each small group to summarise the group's conclusions and then post these opinions in a larger group discussion.

Some teachers assign a grade to ensure all participate. However, McKendree et al. (1998) found that forced participation can substantially lower the overall quality of online discussions. The same study also found that a large proportion of students not posting messages were still participating but in a vicarious manner. Sutton (2000) argues that it is possible to have 'vicarious interactors' who process the interactions of others without posting any messages.

Students will participate in CMD if they value the reasons for doing so. Teachers can help students realise the benefits of using CMD by showing students hard data (this may require some research) on how participating in a CMD is an integral part of learning and the development of their understanding, which can therefore lead to an improvement in performance and grades.

9. Monitor and Evaluate

Monitoring and evaluation aids the teacher in understanding how both task and tool affects the learner. Some evaluations on the use of CMD have discovered that females tend to participate less than males and were even less likely to be involved if the tasks were adversarial (Gregory 1997, Herring 1992, Ferris 1996). Such evaluation help sensitise teachers as to what they need to be aware of when planning CMD tasks. As CMD is a relatively new tool in higher education, there is a need to further explore how, when combined with different tasks, it impacts upon student learning.

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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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