

*This issue of CDTL Brief on **Use of IT in Education** discusses how IT can be used in various context to facilitate teaching and learning as well as factors that motivate or discourage faculty to adopt IT in teaching their courses.*

Innovative Use of IT: A Surgeon's Perspective

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The world has evolved and we are now living in the age of nuclear weapons and silicon chips. This is also the age of computers and information technology, commonly referred to as the 'e-age'. It is ironic that man made machines and computers, and now these gadgets are used to clone and make a 'brand new' man or robot that can substitute humans in performing repetitive tasks or work that demand a high degree of precision! Advances in IT have made a tremendous impact on medical education and training, resulting in continuous changes in our field.

There is an ever-increasing dependence on computers in all spheres of life and we, as surgeons and educators, are expected to learn to use the computer for everyday office tasks (e.g. writing documents, collecting data and preparing spreadsheets, and putting a presentation together) just like a toddler is expected to learn the alphabet. The Internet has become part of existence. We feel suffocated and cut off from the world when we are denied access to our email even just for a day.

Looking at the bright side, we have all gained immensely from technological advancement. The Internet provides easy access to a whole lot of medical literature that was either unavailable or expensive earlier. We now have access to leading

journals online, many of which are free. In addition, the Internet's search engines grant its users access to an immense amount of information on any subject under the sun. Data access is no more an issue; the world has become smaller.

A number of web-based learning programmes and websites are now at both students' and teachers' disposal. Medical students can actually attend an online tutorial through the IVLE by reading the steps of surgical procedure and viewing digital video recordings of how various operative procedures are performed by pioneers and experts in every field. Online forums facilitate class discussion and debate on different clinical practices and difficult clinical cases.

The first computer invented by Charles Babbage at the turn of the 19th century was a gigantic machine that needed an entire room to accommodate it. However, with the invention of the silicon chip and the microchip, that monster has become extinct. Now, we not only have light, sleek and portable laptops, but also a variety of fanciful Personal Digital Assistants (PDAs) to choose from. The PDA is gaining popularity because of its functionality and size. Healthcare professionals can use the PDA to search drug databases, understand more about disease management protocol and calculate different

medical formulae at the press of a button. Also, many standard medical textbooks are now available in PDA format and these serve as ready references.

Virtual and simulated training has increasingly become integral to many educational programmes. Medicine, especially surgery, has adapted the technology used in virtual flight simulators to create virtual models that allow a trainee surgeon to get a feel of endoscopic surgery. In addition to working on depth perception on a two dimensional visual display and enhancing hand-eye coordination, these simulators endeavour to take a trainee surgeon through an operation step-by-step, allowing him to familiarise himself with anatomical planes and tissues. The simulators are now available to train our postgraduate doctors in upper and lower gastrointestinal endoscopy, urological percutaneous procedures, angio-vascular stenting, gynaecological surgery, basic to advanced endolaparoscopic tasks, cholecystectomy, ventral hernia repair as well as gastric bypass for obese patients with different degrees of difficulty. With the latest models offering haptic and tactile perception, it renders the continuous development of such educational tools more and more important in all training programmes. Training surgeons with simulators avoids exposing patients to unnecessary risks when trainee surgeons practise on them. Virtual and simulated training comes with a host of obvious benefits. Studies have validated that surgeons trained with such training methods showed improvements in medical and surgical skills.

Today, medical training programmes are different from the past where didactic lectures were the main mode of instruction. Now, a modern, integrated medical training programme involves dry laboratory and live-tissues training, as well as practising on surgical simulator and discussing surgical videos. Mentoring and proctoring activities can be arranged using communication technology—a science that in the medical field due to various problems and difficulties (e.g. high cost, needs of Integrated Services Digital Network [ISDN] lines, broadcasting equipment, Compression-Decompression devices [CODEC]), has never been widely accepted and utilised. The conventional telemedicine is utilised to beam radiology (Computed Tomography-scan [CT-

scan], Magnetic Resonance Imaging [MRI]) or vital signs (blood pressure, electrocardiogram [ECG]) but with some limits as still pictures and small size images (in cases of live images) caused by CODEC affect the quality of the images and amplify the delay between audio and video. The existing technology utilises bandwidth of 128 kilobits per ISDN line and usually three lines are utilised with a total of 384 kilobits. Even with the availability of Asymmetric Digital Subscriber Line (ADSL) technology for broadcasting, we still need to compress the images for transmission. The key factors for a successful telemedicine/telesurgery are: high-quality images, high-speed connectivity, little time-delay and multi-channel broadband. We started a project utilising the high speed broadband technology of 30–35 megabits per second (Mbps) to broadcast live-telemedicine/telesurgery. This technology, with a high frame rate video signal, allows users to utilise non-compressed images for broadcasting.

In the surgical field, robotic surgery utilising the Da Vinci® system (see <http://www.intuitivesurgical.com/index.aspx>) has gained popularity worldwide and promises significant benefits for patients especially in such fields as cardiovascular surgery and urology. With the addition of 3-D vision and seven degrees of freedom, tasks like suturing and micromanipulation are simpler than with conventional endolaparoscopic surgery, where 2-D vision and restricted movements (only three degrees of freedom) must be compensated by a surgeon's dexterity and skill. Robotics has hit the industry in a big way. Though its use is limited to a few surgical fields as of today, it has opened a Pandora's Box. Its applications will definitely increase with time, accommodating a wider range of dexterity and technique. Research is underway to allow unmanned state-of-the-art vehicles to pick up wounded soldiers from combat fields, scan them from head to toe, start primary resuscitation in a matter of minutes, and subsequently, fly them out in unmanned helicopters to the nearest medical base. The implications are enormous.

We have developed a breed of machines that may soon outlive and overpower the masters who created them. The science fiction movies depicting robots replacing mankind may soon become a reality. ■

Let Go of My Lego!

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Introduction

In the modern classroom where IT usage is taken for granted, what can I possibly say that will interest my readers? Worse, what innovative use of IT in pedagogy can possibly excite students like those in the School of Computing who are already avid users of computer technology?

All freshmen at the School of Computing are required to take CS1101 “Programming Methodology”. This module is to computer science what arithmetic is to mathematics. The module and its variants have been with us since the age of 8-bit microprocessor (the early 1980s). Unfortunately, over the past two decades, many freshmen, who already knew how to do programming, viewed the module as a bore and a chore. However, weaker students liken programming to lion-hunting in the Sahara desert. Even if one survives the tedium, he/she might still end up getting mauled by the lion. Thus, when I was offered to teach the class in Semester 2, Academic Year 2003/04, I resolved to change this stigma.

Background

From mostly a pen-and-paper affair at the dawn of the computer era, computer programming and how it is taught, have changed over the years. The main vehicle through which students learn the nitty-gritty has evolved from text-based exercises to involve Windows, Icons, Mouse and Pointers (WIMPs), and more recently, sound as well as animated images. It seems therefore logical to make the next evolutionary leap to incorporate robotics in programming. After all, toy robots, such as the Lego Mindstorms™, are readily available. Moreover, robots are perceived to be the epitome of machine intelligence.

However, computers do not understand English. Programming language consists of cryptic symbols like: `while(*ptr++!=0){*ptr%=*ptr+2;}`. To the untrained eye, this is no different from expletives found in comic strips. In addition, we have a myriad of programming languages to choose from, some popular, some so arcane as to border on the insane. No wonder our staff struggle to teach CS1101 and students perceive it as a torture.

Robot Pedagogy

Pedagogically speaking, using a robot to teach programming accomplishes several goals. First, the concept of abstraction is made explicit—coordinating the various sensors, motors and decision-making components of the robot is best done by designing software layers with clear interfaces (i.e. abstractions) between them. There is also the abstraction between the robot’s hardware configuration and the controlling software to consider. Second, students get a hands-on introduction to embedded systems (where the computer is part of a larger system) and the engineering issues arising therein. Programs that run on a desktop PC do so in a ‘perfect’ environment; adding one and two always produces three. If the result is wrong, it is due to a program bug. But this does not always happen in the real world where sensors and motors are imperfect. Instructing a robot to move in a straight line may produce a curved path instead because of tiny imperfections in the wheel-size, in the speed of motor rotation and so on. In an imperfect environment, a wrong result is not necessarily caused by a ‘buggy’ program. Students thus begin to appreciate the complexity of building real systems and the need for reliability engineering. Furthermore, as the robot is a resource-scarce platform with limited battery power and memory space, its CPU runs considerably slower than on a full-fledged desktop PC. These allow students to get a taste of how such constraints affect their program design. And finally, controlling a robot is inherently fun. The satisfaction of seeing one’s creation come alive and the robot obeying every command cannot be gained from traditional desk-bound programming exercises.

The assignment that I give students is a simple one: program the robot to draw patterns on a piece of mahjong paper on the floor. Attached to the robot is a marker pen which can be raised or lowered to make contact with the mahjong paper. The robot draws by moving forward or backward while the pen is down. Disjointed lines may be drawn by raising the pen, moving the robot to the new position, and lowering the pen. Turning the robot is achieved by driving the left motor forward and the right motor

backward. The assignment builds up incrementally: first, students program the robot to execute the basic movements for moving forward/backward, turning, and raising and lowering the pen. Then students choreograph these basic movements to produce more complicated drawings, such as writing letters of the alphabet, words, or even fractal pictures.

In a variant of the assignment, I ask students to select a mystery symbol from a box, and then reprogram the robot to draw the symbol within five minutes. This challenges students to prepare useful program abstractions beforehand in order to meet the time constraint. If students have attempted to 'code from scratch' they would not be able to accomplish the task in the allotted time. Throughout the whole assignment, there is a lot of trial and error in getting the robot to 'behave' correctly. Robotics is not an exact science! Students learnt to be patient, to anticipate the outcome of their programs and to troubleshoot when things go awry.

To add a competitive element, I also conduct an optional drawing contest. Students are free to get their robots to draw anything within six minutes, and their drawings are judged for aesthetics. The winning team is rewarded with chocolates and candies. Some of the pictures are remarkable for their novelty and creativity. I have seen drawings of a Christmas tree (crooked because of the imperfect lines), the Greek symbol lambda λ drawn to perfection, a penguin wearing a bow tie and a beach scene complete with sun, sand and umbrella. There was even an attempt to draw the NUS Centennial logo! While most of the drawings honestly resembled chicken scratching, I am delighted to see the sheer creativity students displayed.

Conclusion

How do students find this robot assignment? Here are some comments:

- “This lab, while extremely interesting and entertaining, certainly had its challenges. It’s like a simple issue of mind over matter, where in the mind (our program) is theoretically accurate, but the matter (our robot) decides to have a finicky mind of its own; hence we chose its name to be FussBot. ... Writing letters are [sic] something that a small toddler can even complete with more accuracy than our robot, and at some points, we felt as though we were the robot’s parents, trying to coax it to work and constantly gauging its progress.”
- “Once we have our robot fixed, we then tried to make the robot travel in a straight line. Apparently, we did not know that the motors of the robot had to be calibrated, and thus, our robot went in circles instead of going in a straight line. ... Apart from that, it really was an enriching and interesting way of ending the semester.”
- “I did enjoy this assignment ... I found that this robot is so cute...thanks for providing us with such a wonderful lab!!!”
- “Lab 8 is time-consuming.”

I believe these comments speak for the value of such an assignment. A survey conducted at the end of the semester revealed that almost everyone agreed that the robot assignment was fun and instructive. Fewer students, however, agreed that this should be a required assignment in every introductory programming module. Personally, I find it gratifying to go beyond the traditional mode of desk-bound computer programming. It is doubly satisfying to get students to work hard and have fun at the same time. ■

IT and Experiential Learning

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The ubiquity of information technology (IT) in our daily lives is obvious and everybody acknowledges its usefulness in education. This article focuses on the use of IT to facilitate learning, highlights different aspects of using IT in teaching and learning and explains why the potential of IT in teaching and learning may be underestimated.

We learn daily from experience; our minds and behaviours are shaped by our interaction with people and the environment. Our mind interprets a continuous stream of multimodal sensory data received from our five senses (touch, smell, vision, hearing and taste), and transforms these into

knowledge, personality traits and other attributes that define a person. To increase or to make learning more efficient, we go to school, read books, watch movies, engage in intellectual discourse and activities (e.g. play, work) with one another. The auditory and visual senses are perhaps most widely-used when one is learning in an educational institution. Learning is also supplemented by other senses (e.g. our sense of smell in laboratory experiments in chemistry).

But what is the role of IT in learning? How can IT facilitate learning? There are many answers to these questions, but I believe one of the ways IT facilitates learning is its ability to simulate a system according to some mathematical model. A system here can refer to a phenomenon, an event, a tool, a machine, or anything we can imagine. It can also represent reality or something fictitious. A system accepts inputs, produces outputs and has internal parameters which describe its current state. A mathematical model consisting of equations describes the timed evolution of both outputs and internal parameters of the system in response to various inputs.

I believe the most important role of IT in learning is its ability to create virtual worlds that we can experience in any way that we, as its creators or inhabitants, prefer. In other words, IT empowers its human creators to create artificial worlds with rules of nature defined by their creators. The following are different levels of control that facilitate the learning experience and perhaps, develop the inner creative abilities:

- *Time*: Users dictate how fast or slow time progresses in the virtual worlds. By controlling the pace, users can experience their worlds in slow motion or at high speeds.
- *Scales and levels of detail*: Another useful feature is the ability to experience different levels of details. For example, one can zoom in and stay inside a machine's part or component that one is designing and witness how the machine works.
- *Amplification or attenuation of senses*: Users or inhabitants interact with the created world using human senses (e.g. sight, touch, hearing). As users interact with the world, the rules defining the world produce the required sensory data that can be amplified or reduced to achieve different levels of sensitivities. The user experiences these data through 'interface devices' that connect users with the virtual world.

The most common interface devices are the keyboard, mouse, joysticks, display and sound. The keyboard, mouse and joysticks allow users to input motion and the virtual world responds through a

display (images) and sound. Currently, there are more advanced interface devices that provide 3-D motion input capabilities and more sensory interfaces (e.g. touch). We are starting to see such devices in the computer gaming world where the player wears certain devices and interacts directly with a computer display. One interesting class of input/output devices is joysticks with vibration capabilities such as those in Microsoft's Xbox and Sony's gaming consoles. Different levels of vibration simulate different magnitudes of explosions or impact.

Another class of systems is those that capture the user's motions such as PlayMotion (<http://www.playmotion.com>). With this system, the user can use his/her hands to push balls that are floating in the air. The system captures the real motion of the user's hand and shows a virtual hand on the display. The user literally sees his/her virtual hand on the display moving together with his physical hands while manipulating virtual objects on the screen (virtual world).

In the prototype and early commercialisation stages is a class of interfaces devices called haptic devices. A haptic device is essentially a small little robot (with many links connected by motors) that acts as a joystick. A handle is attached to the tip of the robot, which the user holds and moves to command 3-D motion in the virtual world. The motors at the joints of the robot exert varying levels of resisting torques so that the user, while holding on to the handle, can experience different levels of resistance. A haptic device that mimics a scalpel used in surgery can be used by trainee surgeons to practise surgery on an internal organ. As the doctor moves the virtual scalpel using the handle of the haptic device, he/she is able to feel the forces as tissues are cut and visualise the whole operation at the same time. The virtual experience can be made more realistic if sound and images are added to simulate blood flow at different amplification levels (see <http://guppy.mpe.nus.edu.sg/~mpeangh/haptics/haptics.htm> for some examples of haptic devices).

In summary, we interact with the real world and learn from our successes and failures. Information technology allows the creation of *interactive digital media* coupled with rich user interfaces that facilitate experiential learning. The virtual worlds created by interactive digital media allow users to experience environments, which follow either the same or different sets of rules as the real world, at different levels. This certainly enhances user's learning experience, facilitates learning and promotes creativity. ■

Using Blogs to Teach Philosophy

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It has been three years since I taught a module that did not have a blog (online journals). I take for granted that much of the value of any module consists in what happens in blog comments, and I find the practice of posting on blogs to be a good discipline. When I teach a module, I try to get as many readings online as possible. I build websites and do not hand out much papers. My lectures are available via webcast for big classes. I have reached the point where this sort of IT-use is like having headlights on a car—if you do not have them, you would not be able to do approximately half of what you want to do.

The future is already here. It's just not widely distributed yet. (William Gibson, 1948–)

William Gibson's quote could be my motto. But one could also say that a pretty thick layer of future is already widely distributed; it is just that some think it is not. Instead, we call the future the 'past'. For example, email is IT, computers are IT, books are IT, a pencil is IT and our brains are IT. Well, that is why the discussion is really supposed to be about IT-use as though every teacher should be an IT innovator. Some people are, some are not, and that is fine. For that matter, the technology (blogs) I am using at the moment is hardly cutting-edge. It is just that not many other teachers use blogs, but they all use email.

So, what are we looking for here? Should teachers simply adopt any new technology that works—just like how our ancestors eventually got used to 'books'? It is not even an issue, since no one opposes new things that work; it just takes effort to spread it around. Teachers teach as they were taught years ago. University teaching is, paradoxically, a rather solitary practice. You meet your students, but seldom see the inside of a colleague's classroom.

Using IT in education does not save labour, but it adds value. This is rather different from using robots and systems to cut labour costs in the industry and thereby add value. Until robots get several orders of magnitude smarter, there is not a lot of education labour they are qualified to save except one possibility: replacing lectures with videos. I am skeptical of this because it could have happened a

quarter century ago with VHS tapes. The fact that it did not speak volumes. What is wrong with canned lectures that are streamed on demand? Well, one thing is that it makes even a small class feel like a big class. That personal spark between individual students and teachers does not fly. A great deal of the energy in good teaching is derived from students' interaction with an actual, enthusiastic person who wants them to learn something right now. No video provides that. Also, the labour cost of a lecture is, for most lecturers, not so much more than the time it takes to talk. Rather, the real cost is the time and effort in preparing to become competent to lecture on subject *x*. The actual delivery is almost an afterthought. But this largely defeats the savings of, say, just putting it all on tape/disk/information crystals of the future. Universities are not going to become video stores. They must have humans who are competent and prepared to teach subjects. That is the fixed labour cost, and the real big-ticket item. So, repeating lectures by just putting them in the can to stream on demand neither saves labour nor adds value to them. Live theatre is better.

But what about big classes where there is not much chance for teachers to have real conversations with students? Admittedly, a canned video lecture starts to look more competitive here. I would no longer seriously consider not offering webcasting for large lecture modules, unless there are obstacles (e.g. copyright problems with my film module, PH2880A "Philosophy and Film"). But this does not mean that teaching and learning in big classes is restricted to students accessing digital archives on demand. Rather, the solution is to seek ways that can make the big lecture classes seem like small ones, and make the small classes more like those 2-to-1 or 1-to-1 tutorial sessions that only went extinct in the recent past.

I have found that blogs work nicely in getting discussions going. There is nothing magical about a blog. In fact its chief technical advantages over, say, IVLE forums consist in slightly more inviting aesthetics. It is a sequentially-ordered set of short texts that does not require a lot of planning, because the presumption is that there is no master plan, just the order the bits go up, and some sort of archival system so you can find old things later. The good

posts can be saved and reused next semester, but much of it is off-the-cuff or ‘something I forgot to say in lecture’ stuff. Between reusing old bits, and just firing off new bits as part of the day-to-day life of the module, a lot of content is generated with rather little effort. If it is informal and chatty, students are not daunted and get in the habit of dropping by to check what is up. Blogs are actually rather socially addictive for many people. And the whole thing can be nicely integrated into a large website and online reading set. Students can click around and link directly to readings. I find requiring students to produce a modest volume of contributions, which are then marked only as satisfactory/unsatisfactory, a useful assignment. This requires students to write a lot, which is valuable to them without it being the

case that all their writing is severely judged (which inhibits production); and without it being the case that the instructor is buried under a mountain of marking. Such an assignment does not require much effort from the teacher.

All the little things add up. The process—building, maintaining and moderating blogs—is very time-consuming. It is a serious investment of labour, but one that pays dividends, especially in large modules that are repeated every semester (e.g. exposure modules such as PH1101E/GEM1004 “Reason and Persuasion” which I am teaching at the philosophy department). Think of it that way and take reasonable steps to ensure that teachers can make the investment to earn those dividends. ■

Factors Affecting the Adoption of Information Technology (IT) in Higher Education

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Introduction

Information technology (IT) refers to an integrated framework of computers, software applications, multimedia content, the Internet, web-based applications, learning management systems (e.g. IVLE) and other tools that can be used to enhance the teaching and learning process. The benefits of using IT in teaching is supported by research and literature also indicates that one of the primary motivators in integrating IT into the curriculum is that it helps to improve the quality of teaching and learning.

Over the past few years, NUS has strived to cater to the IT needs of faculty and students. In an effort to fully exploit IT for teaching, learning, research and administration, NUS launched an on-going global campus initiative and invested heavily in setting up and providing IT infrastructure on campus to make IT readily available. While some faculty have accepted and adapted to new ways of teaching with IT, others resisted. This paper discusses results from

a survey conducted in 2006 which examined what motivates faculty to adopt and use IT in their classes and what inhibits them.

Methodology and Study Participants

In the survey, questions were designed to determine:

- faculty’s knowledge of IT,
- whether faculty use IT in teaching their courses,
- faculty’s self-reported proficiency in using IT,
- whether faculty perceive benefits in using IT,
- factors motivating faculty to use IT, and
- factors keeping faculty from using IT.

Faculty were also asked to indicate their preferences in using IT in their courses and if they envisage using IT to support their teaching in the coming years.

Sample and Response Size

Surveys were mailed to 1721 full-time faculty at NUS. 486 (28% of 1721) faculty responded to the survey either through campus mail or the web-based survey. Faculty were asked to rate the importance of 25 factors that influence their use of IT for teaching purposes on a five-point Likert scale (0 = not important at all, 1 = of little importance, 2 = moderately important, 3 = very important and 4 = extremely important).

Key Findings

The responses were grouped into seven broad categories:

- 1) perceived usefulness,
- 2) perceived enjoyment,
- 3) institutional factors,
- 4) incentives and rewards,
- 5) time constraints,
- 6) inadequate support and training, and
- 7) lack of knowledge and skills.

The frequencies of similar responses were tallied to analyse the patterns of IT usage. This information will be useful in analysing why some faculty resist the use of IT.

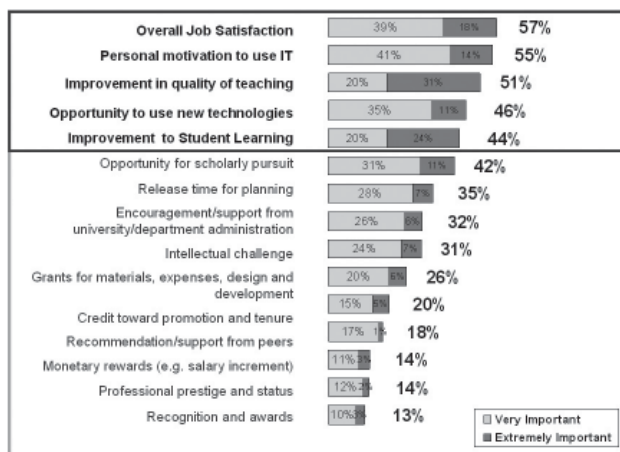


Figure 1. Factors motivating faculty in using IT in teaching

1) Perceived usefulness

Perceived usefulness includes concerns about how IT can improve the quality of teaching and student learning. It is obvious from the results (see Figure 3) that faculty value quality teaching and student learning as it is ranked 47%. Some respondents felt that they would use IT if students' learning experience can be improved, and if students appreciate or indicate a preference for using IT. Most respondents indicated that they would use

IT only if it helps to enhance teaching and learning, and improves communication between students and them. This is evident from responses to the question where faculty were asked to rank the top benefits of using IT in their teaching (see Figure 4).

2) Perceived enjoyment

Perceived enjoyment encompasses factors like intellectual challenge, the opportunity to use new technologies, the opportunity for scholarly pursuit, personal motivation to use IT and overall job satisfaction. From Figure 3, we see that perceived enjoyment is the second most important factor in motivating faculty to use IT. Personal enjoyment and satisfaction from using IT seemed more important than recognition, rewards or incentives to use IT in teaching. Hence, this suggests that perceived enjoyment is necessary for encouraging faculty to use IT and in helping them to overcome any inhibiting factors that may be present.

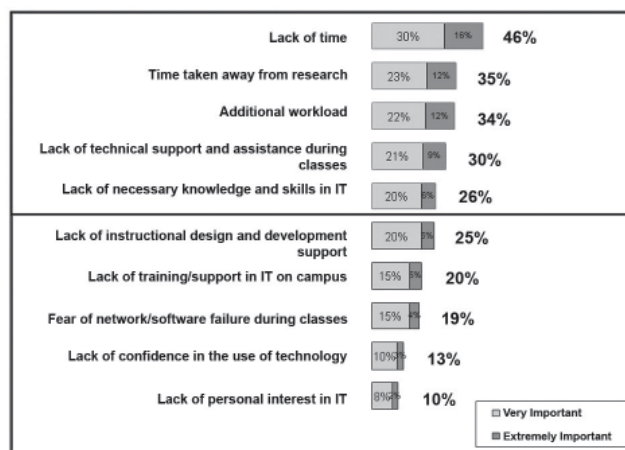


Figure 2. Factors hindering the use of IT in teaching

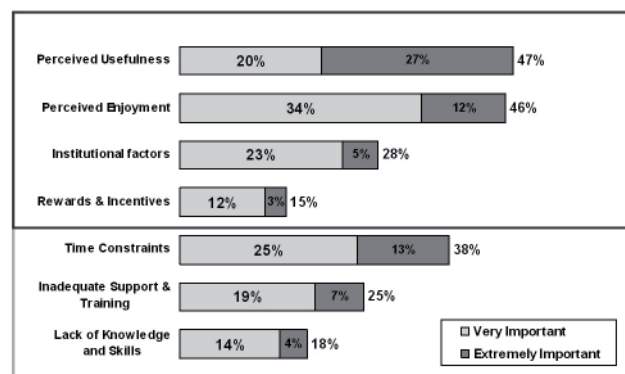


Figure 3. Factors influencing the use of IT in teaching (based on categories)

3) Institutional factors

Institutional factors include time for planning, encouragement/support from university/department administration, grants for materials, expenses, design and development as well as recommendation/support from peers. Though recommendation from

peers is not considered important, the other three factors are ranked considerably higher.

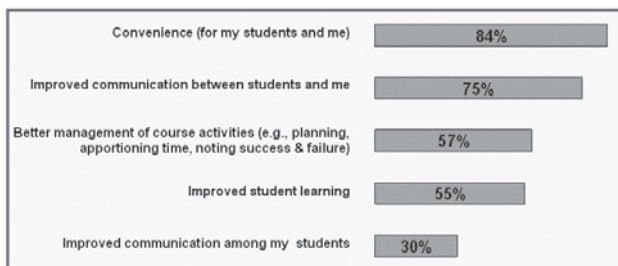


Figure 4. Benefits of using IT in teaching

4) Rewards and incentives

Incentives and rewards were the least motivating factors. Only 15% of respondents felt that these were important. Some faculty indicated that professional prestige, status, recognition and monetary rewards that credit toward promotion and tenure, were not factors that would motivate them to use IT at NUS though these would be good to have!

5) Time constraints

Time is a critical resource to faculty and 38% of faculty cited time constraint as the most formidable barrier to adopting IT. Faculty need time to be familiar and experiment with new technologies and before they can be integrated effectively into the courses, and this takes time away from research activities. Though time is a critical issue, it also relates to the benefit derived from using technology. As one respondent put it, "Some were useful while others consumed too much time at low benefits". Hence, if faculty can see that the benefits of using a new technology outweighs the time spent on learning to use it, he/she may be more open to using IT in their courses.

6) Inadequate support and training

Training and support refer to technical support and assistance available during classes, training/support in IT on campus and instructional design and development support provided by the university. Only one in five faculty members considered the lack of support and training a hindrance to using IT. This might indicate that faculty members are either generally happy with the level of support provided,

or if they can see the benefits and are provided with adequate support at the same time, they could learn to use the technology.

7) Lack of knowledge and skills

As IT permeates into more areas of our lives and becomes more user-friendly, the issue of knowledge and skills becomes less important. When one develops a personal interest in IT and the confidence in using IT, the necessary knowledge and skills can be easily acquired. Technical support also makes IT easier to use.

Conclusions and Recommendations

It is evident from the study that faculty need to realise the advantage and value of using IT. Even though the infrastructure and new technologies are available, faculty will not use IT if they do not perceive any enjoyment or benefits to the teaching and learning experience.

It is recommended that attempts in IT integration should focus on using technology to make a greater impact on the educational experience rather than the acquisition of infrastructure. Time and perceived benefits of using IT to develop courses will continue to be an ongoing issue. The university should think of creative approaches to ensure that faculty have more time to experiment with integrating IT into their lessons. We should also explore ways of teaching and learning that are best supported by IT to enhance students' learning experience.

Further analysis will be performed on the data to see if the factors that motivate or inhibit faculty in using IT have any significance in relation to the following:

- age group differences,
- differences based on the years of university teaching, and
- the extent a particular faculty/school supports the use of IT.

More details will be made available in a future executive summary report. ■

A Conceptual Model to Guide the Use of ICT in Teaching and Learning

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Educators who are out-of-sync with Information Communications Technologies (ICT)'s evolution often feel alienated by it. The reason for this alienation is manifold: first, in their struggles to accept new teaching and learning technologies and second, in the conciliation between the features of new technologies against a teacher's pedagogical beliefs, which includes Pedagogical Content Knowledge (PCK). Put simply,

[PCK] refers to the most regularly taught topics in one's subject area, the most useful forms representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing the subject that makes it comprehensible to others... It also includes an understanding of what makes of specific topics easy or difficult: the conceptions and preconceptions that students of different ages and background bring with them to learning. (Shulman, 1987, p. 9)

Consequently, when non-IT or non-ICT mediated PCK have been successful in many instances, alternative vehicles of mediation will make little sense to the teacher. A lot of effort on the part of leadership and change agents is required to overcome hindrances in adopting new technology. A teacher must be convinced that it is worth analysing the relationships between technology affordances (opportunities) against his/her pedagogical road map. To do this, conceptual models to facilitate connections between the two are necessary to assist teachers in translating technology functionalities into pedagogical content. In this paper, I would like to present these conceptual models.

Conceptual Models

In this section, we look at how contributions in contemporary research have put a face on (1)

educational theories and (2) the intimate mechanisms that link ICT, learning and their sociocultural settings. Next, we examine how two models are integrated to provide a complete picture to guide innovations surrounding the use of technologies in teaching and learning.

Conole, Dyke, Oliver and Seale (2004) remind us that there is already a wide range of educational schools of thought and learning theories such as "behaviourism, constructivism and social constructivism. ... In addition, other models of learning such as Kolb's experiential learning cycle, Javis' model of reflection and learning, Gardners theory of multiple intelligences and Flavell's theory of metacognition have a particular focus and emphasis" (Conole, *et al.*, 2004, p. 18).

To encapsulate these educational approaches, Conole *et al.*, (2004) extrapolated their characteristics and represented them on a Octahedron (see Figure 1) that consists of six components:

- *Individual*—inferring that the individual is the focus of learning.
- *Social*—learning is explained through interaction with others, through disclosure and collaboration and the wider social context within which the learning takes place.
- *Reflection*—inferring that conscious reflection on experience is the basis by which experience is transformed into learning.
- *Non-reflection*—when learning is explained with reference to processes such as conditioning, preconscious learning, skill learning and memorization.
- *Information*—when an external body of information such as text, artifacts and bodies of knowledge form the basis of experience and the raw material for learning.

- *Experience*—when learning arises through direct experience, activity and practical application” (Conole, *et. al.*, 2004, p. 23).

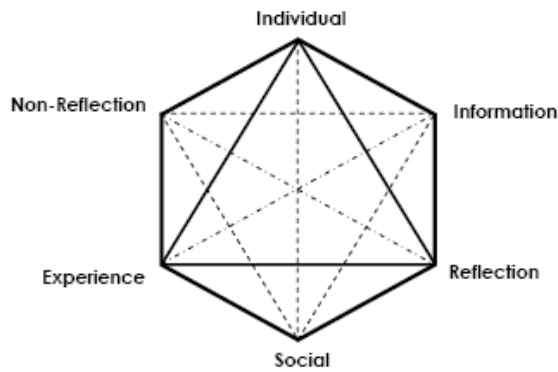


Figure 1. Octahedron encapsulating educational theories (Conole *et al.*, p. 24)

Conole’s *et al.*, (2004) contribution of a clear, succinct and unambiguous oracular aid to plan and order learning activities is indeed a remarkable one. However, commissioning ICT affordances into learning designs must be done against a backdrop of sociocultural factors that could nullify the merits of ICT integration for all they are worth. To paint a vivid picture of this backdrop, Cole and Engeström’s (1993, p. 7) model of activity system (see Figure 2) serves to alert us of “the intimate mechanism that link ICT, learning and their sociocultural settings.” Unmediated functioning occurs along the subject (individual), the object (task) mediated by tools, at the vertex of the triangle. According to Lim (2002), humans abide in groups where labour is shared: the “continuously negotiated distribution of tasks, powers, and responsibilities among the participants of the activity system” (Cole & Engeström, 1993, p. 7), and dealings between the learners (subject) and community are dependent on the groups’ mediating tools/artifacts, and rules, which are the “norms and sanctions that approximate the expected correct procedures and acceptable interactions among the participants” (Cole & Engeström, 1993, p. 7). “Activity theory has been successfully used to analyse success, failures and contradictions without simplifications. It offers a set of conceptual tools that can be supplied to various situations to understand the coupling of cognition and activity” (Lim, 2002, p. 413). The activity model of activity system is dynamic and transcends time where there are continual constructions and reconstructions of high level integration.

When we integrate Conole’s *et. al.*, (2004) Octahedron into Cole and Engeström’s (1993) activity theory, it becomes clear that a teacher must pay a lot of attention not only to the dynamics but also to the

components of the activity theory, in regard to the deployment of education theories (see Figure 3). For example, a teacher might plan to use the social constructivist pedagogy to educate students on the effects of pollution on the ecosystem. He planned to use cases, put questions in discussion forums and assigned roles to students with the aim of letting students make meaning for themselves through role-play (where there is a division of labour in meaning-making). Plotting his design on the Octahedron (Conole *et al.*, 2004), the process of meaning-making is skewed towards experience rather than information, and is nested within a reflective and social setting. But the teacher soon discovered that his students, who regarded social activities as a waste of their time, resisted the role-play exercises. At the same time, the instructional culture of the school centred heavily on blackboard teaching, and that all the PCs in the library available for research work were already taken up by other students.

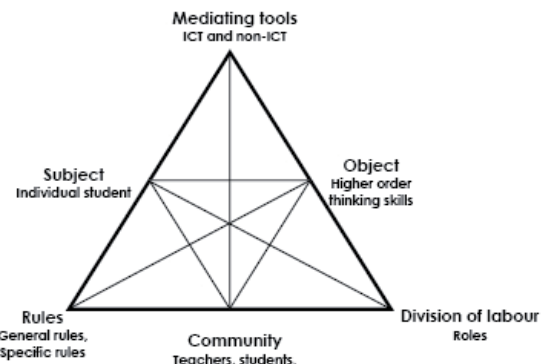


Figure 2. The mediational triangle (Cole & Engeström, 1993, p. 7)

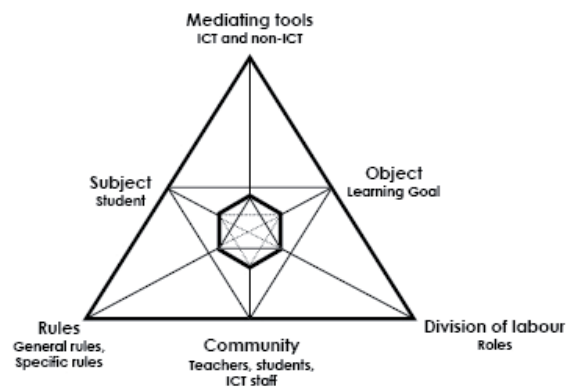


Figure 3. The fortified mediational triangle

Concluding Remarks

The model discussed in this paper can serve as an aid to plan and to scrutinise the purposes and quality of ICT-mediated learning activities, as well as make ICT affordances more explicit when desired educational theories are ascribed to, against the

backdrop of the intimate mechanisms that link technology, learning and the sociocultural settings. The Fortified Mediation Triangle can also be used as tools to advocate or defend pedagogical positions in a learning episode against its intended outcomes. For researchers, the Fortified Mediation Triangle help frame useful questions to study the effects of ICT integration on learner subject matter competencies. For professional development, the Fortified Mediation Triangle helps to identify suitable discussions in ICT mediated learning upon pedagogically informed framework.

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