MOTIVATION

Educationalists have continued to support the view that effective learning can not take place without motivation. As far back as 1983, Steffin,1 (building on the original book iEvents of Instructionî, by Gagne and Briggs2) proposed the first of eight cognitive based requisites for computer aided learning as iproviding for attention and motivationî.

Scott Paris and Julianne Turner ñ authors of iSituation Motivationî3, reflect popular views in education that motivation is a characteristic of people, and they assert that motivation therefore elicits different courses of action, different emotions and different cognitive interpretations of events from learners.

Sue Wynn, iInteractive Multimedia: Ensuring Motivation of the Learnerî4 extends the importance of motivation even further, concluding that ongoing motivation leads to lifelong learning.

As to whether contemporary technological convergence negates this paradigm, was the subject of research at Ngee Ann Polytechnic in Singapore. Parameters of the experiment were set to examine whether the use of IT resources in a formal educational environment would increase or reduce motivation, and hence impact learning outcomes. Contemporaneously, researchers sought to identify whether particular elements of IT design, increased or reduced motivation more than others. Five factors were identified as potential motivators for students in an IT environment:

Opportunity for responsive feedback and individual involvement,
Motivating instructors,
Learners to be active – able to make their own choice of pace and content,
Collaborative learning,
Curiosity and self discovery.

Each of these separate factors were adapted as design elements and incorporated into the Internet site used in the experiment as follows:
Opportunity for responsive feedback and individual involvement

The hypothesis was that responsive feedback and individual involvement would be highly motivating. Internet e-mail and teleconferencing were therefore built into the site design. Students were offered Internet e-mail access to lecturers, and a bi-weekly teleconferencing meeting was also available for their use, whereby students could participate in electronic chat sessions with staff and fellow students.

Motivating instructors

A teacher who cannot motivate students in the conventional classroom is likely to face the same situation using computers. The hypothesis was that multimedia and Internet programs, designed by motivating instructors, should encourage students to learn. The lecturing staff therefore encouraged students and demonstrated a passionate commitment to the Internet Site.

Learners to be active – able to make their own choice of pace and content

The premise of this test was the work done by Paul Pintrich that "when the instructional focus is on practice, rote application of rules and adherence to teacher specified activities, students place little value on the tasks and display less motivation." The Internet site design therefore followed Pintrich's premise that "learners are motivated when allowed to choose how they will act and how much effort they would expend on each task." It was felt that by giving students this choice, motivation, commitment, deep involvement and strategic thinking about tasks, would improve. Students were permitted to choose the path, content, pace and nature of the material, within a framework of "guided discovery".

Collaborative learning

The hypothesis to be tested was the conclusion reached by Maryellen Weiner in her paper "Student Motivation Not a Desperate Situation", that "collaboration builds motivation." The Internet Site design therefore incorporated Class Home Pages, whereby students in each class would work on projects, and post the results of their work on to the Class Home Pages for review by their peers. Paris and Turner also hypothesised that "peer observations and insights often surprise fellow classmates who may have never considered a concept in a way advanced by a classmate." 7

Curiosity and self discovery
It was also suggested before the research work began, that curiosity is an important element in attaining and keeping the learner's attention. The Internet site design therefore enabled the introduction of many changing facets, unavailable with traditional course delivery methods, such as on-demand videos and graphics.

TEACHING AND LEARNING
During the design phase of the experiment, the traditional teaching and learning dichotomy also became a relevant issue for the key design decisions. The question to be resolved was whether the Internet site design should focus primarily on learning outcomes or teaching facilitation.

There are competing viewpoints on education. Instructionists advocate the traditional belief of education, whereby students learn better through improvement of teaching instruction. Teachers are active. Students are passive. Antithetically, constructionists believe that students advance through discovery and participation - learning and remembering, by discovering the specific knowledge they require and not simply receiving it from others. To improve this learning process, constructionists maintain that minimal structured individual guidance from teachers is needed.

In this context, Information Technology (IT) resources, as an adjunct to human teachers, continue to confront educators with opportunities and challenges. Constructionists and Instructionists continue to debate the relative merits or otherwise of IT in support of their respective points of view. For example, constructionists hasten to add, that teachers cannot be replaced with computers. Teachers are extremely versatile and adaptive - their pedagogic ability greatly exceeds any computer learning packages.

We contend this debate is largely irrelevant in an IT environment, and that educators need to distinguish multimedia as a facilitator of learning, rather than teaching. In our view, the concepts of teaching and learning are separate elements of an education closed-loop model that is borrowed from control engineering theory. It contends that teaching is in the forward path of a closed-loop education system, and learning (and hence tutoring) is in the feedback path (Figure 1).

Figure 1 - Closed teaching/learning loop

In this model, teaching takes place using information prescribed in a syllabus. Teaching is seen fundamentally as a process in which a large amount of
information is compressed and delivered by the teacher to the students in limited lecturing hours. Learning on the other hand, is a slow process of digesting and converting information to knowledge and skills, both during and after lecture hours. Consequently, physical attendance at a lecture by a student does not necessarily mean that learning is taking place or taking place efficiently. Learning efficiency varies from student to student and is largely influenced by studentsí capability and motivation. Hence, motivation is represented in the feedback path as a switch.

When student motivation drops to zero, the feedback path is switched off. The system becomes an open loop. Teachers receive no response from students and will try to work frantically, leading to over teaching. In order to avoid an open-loop situation, it is important to kick start the learning process through motivating and helping students to learn.

Once the closed-loop is re-established, teachers begin to receive good responses and feedback from students. Teaching becomes less tedious and professionally more fulfilling. Students begin to recognise their own small achievements which help to further strengthen motivation. In control engineering terms, the education loop is in a tracking control mode.

The teaching function must always be a human one. Teachers are more flexible and efficient compared with computers, when delivering a large amount of information, in digestible form, in a short period of time. Programming a computer to deliver digestible material to replace a teacher is very time consuming and costly. Hence the use of technology as an adjunct to human teachers is more efficient and practical than replacing human teachers with technology.

Since learning is a slow process, computers can be used to help in the learning/tutoring role just like human tutors are employed to help teachers, hence assuring that the feedback mechanism is in place, motivation is high and therefore teaching becomes more rewarding and productive.

This view became fundamental to the design of the IT based educational materials used in the Singapore experiment, and our research, inter alia, sought to substantiate this model, and the consequent implication thereof, that educational effectiveness was thereby enhanced by a strategy of maintaining good teaching by human teachers, conjointly with innovative and motivated learning – learning which involves IT multimedia.

RESEARCH SUMMARY

Ngee Ann Polytechnic in Singapore offers Diploma level courses in 11 Departments, and provides learning for 15,000 students, drawn from Singapore, Malaysia, Thailand, Indonesia, China, and Taiwan. A total of 800 staff is drawn from around the world.
During 1997, the Accountancy Department agreed to research the implications of implementing Internet education as an adjunct to existing course material, in the first year subject, Financial Accounting. To support this trial, an Internet site containing 800 pages of course material was developed. The course material was converted to HTML format from standard word processing documents produced in prior semesters. The process of conversion was done using Microsoft Publisher, and required approximately 350 man hours. The total cost of creating the 800 page site was approximately US$14,000.

The trial was then limited to an experimental group of 111 students from the first year cohort of 444 students. The experimental group comprised 6 classes chosen at random from the 24 classes making up the cohort of 444 students. The selection of students in these classes was undertaken by the Department’s Grouping Committee, prior to the decision being made to start the experiment. The Research team had no involvement in this selection process and the students chosen were as far as possible representative of the entire cohort. No pre-screening of students with minimum computing skills or computing experience was carried out.

To provide additional research material, a concurrent trial was also undertaken with a group of 40 students who had previously failed Financial Accounting, to determine whether the Internet also impacted the learning skills and results of these ‘weaker’ students. The trial began in July 1997, and the data presented in this report is up to and including October 1997.

All Internet material was made available to students from the start of the Semester. In the first week of the trial, students in the experimental group were introduced to the Internet site in both a special lecture and a subsequent tutorial. During each subsequent tutorial, a minimum of 15 minutes in each 2-hour class was used to point out resource material available on the Internet site. Content of material for the experimental group and the control group was identical. At the end of each tutorial, personal e-mail messages were sent by the lecturing staff, to students who performed well, and also to those who appeared to be struggling with concepts or material during the previous class. These messages focussed students on relevant material on the Internet Site, suitable to their progress.

At the end of each week of classes, Frequently Asked Questions were released on the Internet Site along with answers to those questions. This enabled sharing of information amongst the students in the experimental group, irrespective of class.

The experimental group students were also provided on the Internet, with material beyond the core curriculum, particularly more advanced readings, and more difficult questions which incorporated content from all previous week’s topics. In addition, each week, students in the Experimental Group could work through Multiple Choice Questions which focussed on basic principles.
Each class was invited to appoint a Class Webmaster, and then create a Class Home Page on the World Wide Web. The objective of this innovation was to remove fear of the Internet, and encourage more regular use. These Class Home Pages were adopted by all classes, and were located as separate pages within the Financial Accounting Site, to further maximise ongoing student exposure to the Site.

Twice weekly, after hours, additional tutorials were conducted (under the Chairmanship of the Lecturer), for interested students by teleconferencing, using Microsoft NetMeeting. During these on-line evening chat sessions, students asked text based questions of one another and the lecturer. During the coming Semester these sessions will be expanded to include audio and video support. In line with Departmental objectives, learning was to be a 24-hour per day opportunity for students, thereby effectively dictating use of the World Wide Web to deliver the relevant course material and other resources, and enable students to access from home as well as at campus. To assist students in the Experimental Group, computer laboratories were upgraded and the latest versions of all popular browsers were installed. Computer laboratories were made available up to 9pm each day. In the coming Semesters it is planned to issue more students with “on-loan” notebook computers, and work is currently underway to provide login ports in the student canteens, library and open air study areas.

In terms of content and structure, the Internet Site was designed to offer three streams of learning, and within each of these three streams to offer different strands. The chosen streams were for slow learners, average learners and advanced learners. Students were given no overt indication of this “streaming”, and accessed the available strands according to their needs.

**Slow:**
- Detailed Lecture Notes.
- Lecture Examples
- Variations of Lecture Examples.
- Tutorial Questions
- Tutorial Solutions
- MCQs.
- Frequently Asked Questions
- e-mail access, 24 hours per day.

**Average:**
- Additional Questions (same standard as tutorials).
- Library References.

**Advanced:**
- Advanced Readings.
Comments from Practitioners.
- Advanced Questions, combining several weeks of topics at once.
- Access to other Internet sites with University level Course Material.

Students had complete freedom to choose which of the above strands to access, and could move freely between the strands. However, the site was designed to subtly keep students in one of three learning streams until they, by their own choice of material, indicated they were ready to move to the next stream. This was achieved by judicious use of the web page buttons at the bottom of each page on the site. If a student entered the site and initially chose a strand in the Slow Learner grouping, then the web page buttons on that page, only offered other strands within that learning stream. For example, if a student accessed Multiple Choice Questions (thereby indicating the student was more comfortable in the slow stream), then the web page buttons on that page only offered Lecture Notes, Tutorial Questions and FAQ (ie other strands within the same slow stream). The design concept was to keep resources at the student fingertips, which were most appropriate to the student's current level of progress. However, any student could theoretically access any material at any time by reverting to the main index and selecting material at any level ñ the streaming was thus not transparent, but took place discretely.

Academic Results
The following table indicates the results achieved by students in the experimental group, compared with those in the control group, for the semestral 2-hour written examination. This examination covered all course material, and included both theoretical and computational questions. No MCQs were included in the examination. The examination required both computational and theoretical questions to be answered. Three questions were set for completion in 2 hours. Examination papers were then marked by lecturers other than those involved in the research project.

Table 1 - First year Students in Financial Accounting

<table>
<thead>
<tr>
<th></th>
<th>Experimental Group</th>
<th>Control Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>(111 students)</td>
<td></td>
<td>(333 Students)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Grade</th>
<th>1997</th>
<th>% of Group</th>
<th>1997</th>
<th>% of Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td></td>
<td></td>
<td>1997</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>Count</td>
<td>Percentage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-------</td>
<td>------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 90%</td>
<td>12</td>
<td>10.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80% to 89%</td>
<td>22</td>
<td>19.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70% to 79%</td>
<td>29</td>
<td>26.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60% to 69%</td>
<td>27</td>
<td>24.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% to 59%</td>
<td>15</td>
<td>13.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fail</td>
<td>6</td>
<td>5.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>111</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Mean (Mark)
71.4%
64.5%

Median (Mark)
71.7%
64.2%

Sample Size
111
333

Standard Dev
14.0
14.6

The hypothesis we wished to test was that examination results for the experimental group (using the Internet) were superior to the control group (those not using the Internet). In order to test this hypothesis we undertook a one-tailed test for the difference in means. The relevant calculations where (1 = the experimental group, and (2 = the control group, were:

\[
\begin{align*}
(1) &= 71.4 \\
(2) &= 64.5 \\
(1)^2 &= 142 \\
(2)^2 &= 14.62 \\
(1^2) &= 196 \\
&= 213.16 \\
n_1 &= 111 \\
n_2 &= 333
\end{align*}
\]
The test statistic of 4.448 derived from this test is significant at the 0.1% level. Accordingly it can be concluded with an exceptionally high degree of confidence, (99.9%), that the examination results of students using the Internet Site as an adjunct to learning, was superior to students who did not use the Internet site.

As indicated earlier, a concurrent trial was conducted with a class of weaker students, enrolled for another Financial Accounting subject. These students had already failed Financial Accounting at a previous attempt. This Experimental Group of 40 students, were introduced to the Internet Site as an essential element of their learning in Semester 1, 1997. As all students in this class were included in the experimental group, we can only compare their examination results with prior years. Hence we are unable to draw statistically sound conclusions, due to the fact that other factors may have influenced results.

However, prima facie results (Table 2 below), indicate that these weaker students again achieved a statistically significant increase in examination results, which appears attributable to use of the Internet as an adjunct to learning. Prima facie, the improved results appear even higher than for average students, and this is especially encouraging for educators.

Table 2 - Repeating Students in Financial Accounting

<table>
<thead>
<tr>
<th>Exam Grade</th>
<th>1997</th>
<th>% of Group</th>
<th>1996</th>
<th>% of Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 90%</td>
<td>4</td>
<td>10.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>80% to 89%</td>
<td>9</td>
<td>22.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percentage Range</td>
<td>Number</td>
<td>Percentage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------</td>
<td>------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70% to 79%</td>
<td>12</td>
<td>30.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60% to 69%</td>
<td>6</td>
<td>15.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% to 59%</td>
<td>5</td>
<td>12.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fail</td>
<td>4</td>
<td>10.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean (Mark) 70.1%
The following additional data was gathered concerning use of the Internet Site during the last 4 weeks of the Semester, by the 111 students in the large experimental group. A web-counter facility was not installed until late in the Semester, and we are also unable to record which particular students used the site, hence the possibility of the results being distorted by a small number of students using the site regularly, cannot be completely discounted.

Table 3 ñ Statistics of Internet usage

<table>
<thead>
<tr>
<th>Total Hits</th>
<th>% of all Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PowerPoint Lectures</td>
<td>25</td>
</tr>
<tr>
<td>Detailed Lecture Notes</td>
<td>241</td>
</tr>
<tr>
<td>Lecture Examples</td>
<td></td>
</tr>
</tbody>
</table>
Variations of Lecture Examples
11
0.8%

Tutorial Questions
354
30.0%

Tutorial Solutions
210
17.8%

MCQs
75
6.3%

Frequently Asked Questions
90
7.6%

Additional Questions
40
3.3%

Library References
25
2.0%

Advanced Readings
5
0.3%

Comments from Practitioners
80
6.7%

Advanced Questions
5
0.3%

1,171
100.0%
Analysis of Table 3 indicates that students accessed pages offering theoretical material for 22.9% of all hits (viz. comments from practitioners; library references; advanced readings; MCQs and Frequently Asked Questions). This is a disproportionate usage in comparison with the total curriculum balance, indicating that the Internet is fulfilling a learning gap not easily satisfied from other sources readily available to students. There is some conjecture that this result may be attributable in part to the natural curiosity of first year students to learn how to approach and answer conceptual questions. Proponents of this view will undoubtedly argue that as such students become more familiar with these new skills, they will access these pages less, instead electing to concentrate on computational pages and skills. Ongoing research is necessary to respond to this view, but in the interim, results point strongly to improved conceptualisation skills arising from this high usage of theoretical site pages.

This has been measured by the 8% higher number of students in the experimental group who exhibit minimum levels of understanding of accounting concepts, compared with the same number of students in 1996 from a non control group. This result is very encouraging for first year Polytechnic students who have traditionally found theoretical accounting concepts difficult. Anecdotal evidence points toward the cause of this improvement as being due to the streaming design of the Internet site. Advanced students (ie A grades), were measured at a 14% improvement in conceptualisation skills, and struggling students (ie D grades), at a 12% improvement. Average students (ie B and C grades), were however recorded at only a 2% improvement.

This result suggests that the stronger and weaker students are finding course material on the Internet more appropriate for their respective levels of understanding, and are therefore more interested and motivated to understand and absorb that content. Average students are not finding the same opportunities ñ a challenge for future site revisions to address. For first year students, the inability to conceptualise complex new issues such as Inventory Valuation and Cost of Goods Sold has been a significant barrier in prior years. This research result indicates that higher conceptualisation skills are achievable by direct intervention in learning environments. The Internet environment provides resources to achieve that intervention, and to enhance the process virtually on a student by student basis. From this basis, we can confidently move forward into more innovative intervention and direct research into the commercial environments as well. It should be possible to use innovative and stimulating Internet learning environments to impart new skills (both conceptual and computational) to accountants in industry.
TEACHING Productivity Gains

The improvement in academic results already reported in this paper are, in their own right, reason enough to push ahead with further development of Internet based accounting course delivery at Ngee Ann Polytechnic. Unexpectedly however, this work unearthed an equally important benefit, of tangible and direct value to education administrators. Teaching productivity increased with immediate effect. At this point, we should again emphasise this was at no stage an objective of the Internet site, and all design features were focussed on maximisation of learning, irrespective of teaching implications.

Our definition of a change in teaching productivity was the percentage of Semestral time spent in student support or teaching activities, compared with the percentage of time spent in non student support or non teaching related activities.

Measured teaching productivity gains of 16% were achieved in the Semester following launch of the Internet site. Weekly time sheets were kept by the lecturer in charge of each group of students, according to the following dissection. The data is hence only as reliable as the memory recall or accuracy of recording by the lecturer, on a weekly basis. The hours reported in Table 4 below are the aggregates over the 13 week Semester.

Table 4 - Productivity Gains

<table>
<thead>
<tr>
<th></th>
<th>Student Contact/</th>
<th>Teaching Related</th>
<th>Non Student Contact/</th>
<th>Non teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial Period</td>
<td>24%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous Semester</td>
<td>22%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trial Period</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous Semester</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class Contact</td>
<td>24%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student Consultation</td>
<td>12%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Staff Meetings

1%
3%

Exam Administration/Marking

3%
3%

Curriculum Development
30%
26%

Typing Lecture Notes/Materials

4%
16%

Lecture/Tutorial Follow-up

7%
10%

Student e-mail contact
5%
1%

Internet Site Administration

5%
0%

General Administration
Some effect from the high preparation load imposed the previous semester by the shift to IT, must be present, and hence we are not in a position to conclude other than an indicative result, until another semester has elapsed, and there is more comparability in this data. The initial assessment however is of such magnitude, as to warrant interim and immediate disclosure in this paper.

Time previously spent on typing of lecture and tutorial material decreased from 16% to 4%. This arose as a direct result of having the relevant course material, particularly lecture examples, past examination questions, and past tutorial questions, already prepared on an IT platform on the Internet site, thus enabling rapid modification to suit the demands of students each week, and enabling rapid preparation of questions with slightly varied data content.

The time released from these otherwise cumbersome manual and administrative tasks, could then be directed towards increased student contact hours, both at face to face contact level and e-mail communications. In particular, time devoted to individual and small group student consultation increased from 6% to 12%.

Productivity gains of this magnitude are of course very significant when extended across a campus of 800 lecturing staff. If such gains were translated into all other Departments at only 25% of this level, then each student on campus could have 2.5 hours per Semester of one on one consultation with a Lecturer. Personal contact hours at this level would have an immediate positive effect on academic results and the quality of education provided at Ngee Ann Polytechnic.

The challenge for administrators, is of course to translate such productivity gains into student contact hours, and not let them be lost in alternative
administrative activities. In certain environments, we acknowledge that such productivity gains may instead result in permanent reductions in staff numbers.

CONCLUSION
In this paper, we have reported recent evidence to support proponents of multimedia and Internet educational tools, who have long claimed the potential of such tools to improve learning outcomes. This experimental work done in Singapore re-affirms the long established link between improved learning and motivation, but provides direction and focus to IT practitioners awaiting research results to demonstrate that motivation can be engendered and maintained in an IT environment.

REFERENCES


7 Ibid.

Ibid.