Increasing engagement through artefact enhanced learning


**Abstract**

First impressions count. If engagement and enthusiasm characterise our level four certificate students in Information Technology, the chances of retaining these students and having them feed into our degree course increases. This paper describes an approach where fascinating gadgets are introduced into the classroom. A case study using Artefact Enhanced Learning is presented and results from the first class are analysed. Compared to previous years the percentage of students continuing on to further studies was considerably higher. The artefact based project learning appears to be successful as a means of motivating and exciting students.

**Keywords**

Artefact Enhanced Learning, engagement, retention

**1. Introduction**

Accepting that the early experiences of students are critical for both recruitment and retention we set out to create an educational experience that was as much motivational and fun as it was enlightening. This paper examines the role of introductory programmes in enhancing recruitment levels for further study. We hypothesise that highly engaged students are more likely to remain committed to a path of study. We describe the approach first by introducing the concept of Artefact Enhanced Learning (AEL). Then we present a case study which is an example of this approach. Three months after the course had finished we surveyed the students who had continued their studies with us, giving us an insight into their impressions of the feeder programme. We wanted to know how they compared the artefact based project topics with the more traditional topics in an attempt to gauge the scope of the contribution this form of delivery had on the student's decision making processes to commit to further study.

**2. AEL: Artefact Enhanced Learning**

Research reports on the use of artefacts in the classroom forms a crowded continuum from teacher-centred display equipment, like data projectors, to the use of gadgets that the students play with in class. Most attention has been focussed on the use of teaching technology and ways to measure its effectiveness (Spotts 1999) especially in K1-12 Mathematics (Sfard & McClain, 2002). Part of our attention on artefacts is to establish a comprehensive taxonomy of classroom artefacts.

**2.1 Artefact Categories**

We have followed Ching et al (2003) in broadening the concept of artefacts to cover classroom objects such as display boards and furniture and include ambient conditions like lighting and temperature while not excluding gestures and white-board inscriptions. Our classification of classroom artefacts contains the following types: concrete carriers (desks and chairs), concrete conveyors (whiteboards and the like, displaying explicit representations of subject matter), inscriptions (written displays), texts, virtual artefacts (conveying information by gesture and body language), ambient artefacts (sound, temperature, lighting and access) and finally fascinating gadgets.
All such artefacts can have a surprising impact on learning. For instance on entering a room with all the students' chairs in a circle without tables or teachers' desks might imply an egalitarian discussion mode of learning. On the other hand the standard lecture theatre with seats bolted to the floor all facing the lecturer's podium would convey an expectation of minimal student movement and contribution. Ching et al (2004) were "amazed" that during student interviews concerned with lesson delivery ambient artefacts figure so prominently. Such prominence is a pointer to increasing student engagement.

2.2 The Fascinating Gadget

The final category in the above taxonomy is the "fascinating gadget". This is a light-hearted term for a serious teaching tool that emerged out of discussions on marketing IT courses to previously unsuccessful students. Initial informal presentation of such gadgets produced excellent props upon which to pin theoretical ideas and general statements about embedded design and control. Students display enthusiasm and delight at the way embedded intelligence can take the form of toys, flying objects or sporting goods. Our observations incline us to the view that learning is enhanced by such fascination and as an unintended consequence; the teacher too becomes more positive and cheerfully interactive. Currently the enthusiastic anecdote for artefact enhanced learning outruns solid evidence that learning is indeed enhanced but we are constructing a model that might lead to such formal conclusions.

2.3 AEL Teaching Assumptions

The first part of the model is the above taxonomy so we can at least classify artefacts used in the classroom in studies of their relative importance. The second is a list of assertions about the teaching in an artefact enhanced learning environment. We have couched these in terms of ten standards upon which AEL can be judged along with evidence that these standards have been achieved.

1. AEL teachers can plan different varieties of lessons.
2. Teachers in an AEL environment know how to assess.
3. The AEL team knows how to evaluate itself.
4. The AEL process in the classroom is connected with other teachers, industry and stakeholders.
5. AEL teachers understand that students learn in different ways.
6. AEL teachers know the subject area to which the introduced artefacts belong.
7. AEL teachers are excellent communicators.
8. The AEL environment uses appropriate artefacts and converts popular gadgets into illustrative tools.
9. The AEL teacher knows how to manage a classroom.
10. The AEL environment is popular with students and valued by peers.

2.4 AEL and Experiential Learning

The final claim for the AEL model is that, while it shares some of the claims of the experiential learning enthusiasts (Anon 2005), it has important differences.

1. The "experience" is de-emphasised as a goal. Rather, there is an outcome directed, curriculum based, formally assessed flavour in AEL.
2. Whereas the active-passive continuum leans towards participation, the teacher is still the expert and central director. The teacher is the source of inspiration and does not withdraw from the learning process.
3. There is no place for training exercises or "warm-ups" designed to emphasise the experiential learning model's objectives, rather there is an assumption that the students are already ready and motivated and AEL will enhance this.
4. Although there is a shared tolerance for making mistakes there is usually a right way of reaching certain outcomes.
5. In AEL there is a stronger emphasis on debriefing what was learned. This is often tested formally using traditional methods. While there is some reflection at higher cognitive levels, meta-learning is not emphasised.
We hope to bind the three parts of the AEL model, namely the taxonomy, the teaching standards and the links with experiential learning into a formal entity in the near future. The testing of claims made for an enhanced learning environment will become the subject of future research. The team is using teacher discussions as ways to reflect on the above and soon formal evidential criteria based on the University of Wisconsin-Stout (2005) portfolio demonstration requirements will be introduced as a trial.

3. Case Study

An introductory programme plays a dual role. It needs to prepare students for further study, ensuring core competencies are met and also it needs to excite and engage the students so that they actually do progress to further study. This is a difficult mix. In the previous six cycles of the Certificate in Information Technology (Level 4) at Otago Polytechnic the average programme completion rate was only 61.9%. Unfortunately at the time of writing our request for data on continuity of study for these students was not available.

It is a sensible goal to generate maximum interest, interactivity and attachment to the school in this feeder group of students. We decided to utilise artefact based project work to cover the course requirements of three papers. The lab work focused around two projects.

3.1 Project 1

For the first project the objective was to control a cheap ($20.00) two channel remote control car using SMS text messaging (Figure 1).

![Figure 1. Artefacts for the first project](image)

The reasoning behind our choice of artefact was that most of our students had cell phones, identifying them as synonymous with their generation and that the remote control cars would provide a focus outside the computer that responded with colour, sound and motion. They could also be "crashed" with little damage and total student safety. Once the class had an understanding of the objective an abstract solution was presented to them. Analyses of this solution identified the technologies that were needed to meet the objective thus facilitating a commitment by the students to learn how to use these technologies. We then explored the technologies with the explicit objective of gaining sufficient understanding to pursue the project and the implicit objective of covering the curriculum. This resulted in learning outcomes for networking (radio, cellular topography, telephone infrastructure, TCP/IP, digital packets and frames) microcontrollers, RS232, modems and AT commands, programming in BASIC (data types, variables, capturing a string, searching a string, if statements and loops) as well as some simple electronics (using a transistor as a switch) and, of course, a desire to make the cars do doughnuts.
Students built RS232 sniffer cables so that we could monitor machine to machine communications. They sent SMS text messages to a cellular modem and retrieved them into a communications application. This allowed them to view the data in ASCII and hexadecimal. They disassembled the remote control console for the model cars and used multi-meters to deduce how it worked. They wrote simple programs for the microcontroller that activated LED's, via strings communicated serially from a PC. Transistors were then added to the control console so that the micro-controller rather than the PC could activate the controls.

Finally SMS messages were sent from the cell phone to the receiving modem. This in turn was interpreted by the micro-controller which operated the remote controls to move the car. We needed to devise our own instruction set which controlled the way the car operated. Each step was presented as a milestone towards the final objective. Once basic communication and control were established the students were then challenged to expand the micro-controller program and our own instruction set to achieve defined missions.

3.2 Project 2

The second project also utilised a micro-controller but this time the students were required to devise a method of ordering coffee from the Student Centre using a laser light as the communication medium rather than radio via a cell phone. In this project they were encouraged to experiment and discuss possible solutions in groups before presenting their ideas to the class. The objective in designing this project was to devise a scenario where students could apply their newly acquired understanding of how a given set of technologies work to solve an interesting problem. We then consolidated their ideas in class by discussing the strengths of each proposal and then identified the simplest solution. These ideas were then divided among the class for further development with the intention of the lecturer building a single prototype.

4. Results

While this trial has only run once, some of the results seem extremely promising. The historical 61.9% completion rate has dramatically improved to 96% (23/24). Of the original class, only one student did not complete the certificate course and half the class enrolled for a further three years study in our Bachelor of Information Technology Degree. Two others went on to university studying subjects other than computing and one student was intending to enrol in the BIT at Christchurch Polytechnic after moving over the summer. We collected data from those who chose to continue their studies with us.

Twelve students of the CIT cohort entered the Bachelor of Information Technology degree in the second semester. We surveyed them three months later to gain their impressions of their experience with artefact based project learning. Our survey covered five topics. Three of the topics could be classed as traditional: the Internet, spreadsheets and programming. The other two could be classed as artefact learning: project 1 (remote cars and SMS), and project 2 (coffee ordering system).

We asked them three questions for each topic, with a Likert scale for each. How enjoyable did you find this topic? How useful was this topic in helping you in the first year of the BIT? Should CIT have less of, the same amount of, or more of this topic?

Table 1 shows a summary of the questionnaire results.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Not enjoyable</th>
<th>Enjoyable</th>
<th>Very enjoyable</th>
<th>Not useful</th>
<th>Useful</th>
<th>Very useful</th>
<th>Less of this</th>
<th>Same amount</th>
<th>More of this</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote cars</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coffee</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ordering</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Internet</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Interestingly, their responses were not what might be inferred from the improved completion figures. In the enjoyment stakes nobody rated the traditional subjects as not enjoyable. 22% rated the remote cars as not enjoyable and 44% rated the coffee ordering system as not enjoyable. We suggest the coffee system got a poor rating
because while they planned and designed the system they did not actually build it.

Regarding the usefulness aspect, the traditional topics came out on top with everyone rating them as useful or very useful. 44% rated the remote cars as not useful to their studies in the BIT and 78% rated the coffee ordering system as not useful. One person did rate the remote cars as very useful. It should be noted that three months into the BIT programme the students have not yet encountered papers that utilize any of the technologies that they were exposed to with the artefact based projects or project based learning in the degree. This response could well change once they have completed their first year of study.

Regarding the time spent on the projects, most people (78%) wanted the same amount of time spent on the remote cars, one person wanted more and one person wanted less time on this topic. For the coffee ordering 49% wanted less time spent on this. For the traditional subjects most people (96%) wanted the same amount or more time spent on these with the exception of one person wanting less time spent on the Internet topic. Figure 2 shows these comparisons.

![Figure 2. A comparison of the amount of time students thought should be spent on each topic](image)

### 4.1 Enjoyment

Anecdotally students have stated that the best part of the AEL approach was that it was "fun" and "cool". Rather than design yet another spreadsheet showing a trader's profit and loss account, students could program colourful little radio controlled cars to go around obstacles and each other. An unsuccessful run might lead to a crash or wrong initial direction. This brought mirth and immediate peer feedback as to the problem and the solution. Such engagement is a form of rapid prototype development albeit with a loose, spontaneous methodology. "Enjoyment" is a factor that should not be under rated in learning and retention.

There is the associated "glamour" factor that still has appeal for some students despite reports that the dot-com bust has lead to a decline in IT jobs. Also taking the shine off the IT vocation area is the reported higher profile of other subjects such as bioinformatics and molecular biology which are capturing the imaginations of high school students. (Denning & McGettrick, 2005)

### 4.2 Retention

Internationally there seems to be a crisis in IT retention and uptake in student tertiary numbers. Denning & McGettrick (2005) state that numbers of new university IT students in the US fell by 60% between 2000 and 2004 and once the students did enter computing courses drop-out rates of 35% - 50% were common. Our Artefact Enhanced Learning emphasis came about via teacher discussions on responding to recruitment and retention issues. Much marketing effort and spending these days goes into attracting new students into IT courses. The advertisements invariably show pictures of engaged students gathering around interesting equipment involved in some exciting group project. The reality is often different. Beaubouef & Mason (2005) examined students' experiences between the time they commit to major in computer science and the time some dropped out of the institution. Several interesting conclusions are of relevance to our study. First, most dropping out takes place early in the course. Secondly students were not well advised as to the true nature of the courses and left because they were expecting different classroom experiences. Thirdly, students were not given enough practice and feedback. Even the tests were automatically graded and
little individualised assessment discussion took place. Finally there was an implied lack of respect for the subjects the students were taking by according them only graduate students as teachers, rather than senior staff members. In the classroom, communication difficulties sometimes detract from the learning experiences of neophyte students in a course led by a graduate student (Beaubouef & Mason, 2005).

Our AEL approach addresses most of the above issues, partly through the natural outcome of being a small, friendly institution but also as a deliberate strategy of enhanced engagement through the use of interesting artefacts in the classroom.

4.3 Usefulness

Our study produced comments about our artefact based courses being more useful than some other courses known to the students. Students are not always the best judges of the future utility of a given IT topic. However their perceptions are interesting to IT professionals and marketers. To control a "thing" via a little set of commands is different from writing a large abstract program involving, say, objects and data structures. ACM (Association for Computing Machinery) has recently mounted a campaign to drive the message home to high school students that narrow object oriented Java programming is not the only product possible from an IT graduate. (Denning & McGettrick, 2005) They maintain that "...the important point is that innovation can be learned and a spirit of innovation can permeate through our courses starting from the first year and building up expertise in innovation through to their final year" (Denning & McGettrick, 2005, p.17). They go on to say that the "...first challenge is to embed the foundational practices of innovation into the curriculum so that students learn innovation by doing, without necessarily being aware they are engaged in systematic processes." (Denning & McGettrick, 2005, p. 17). Our group asserts that such a philosophy enhances usefulness for further research, for general life skills, for retention and for the IT job market. In addition, nearly all countries are demanding an innovative economy where ex-students are practised in producing technically profound artefacts and solutions. (Denning & McGettrick, 2005, Clark, H. 2002) Repositioning the emphases in tertiary IT courses is an appropriate response to such demands.

5. Conclusion

In this paper we speculate that student engagement in IT courses is enhanced by deliberate placement of interesting artefacts in the centre of the learning process. We assert that such engagement leads to better retention and flow onto higher courses. Our survey amongst students of one class reinforces some of our assertions and points the way to a more formal study. In the process of justifying our methodology we have developed an Artefact Enhanced Learning model with associated teacher styles and expectations. While we have addressed some of the engagement issues and reasons for student withdrawal from IT courses, much work remains to be done to more precisely identify the operational characteristics of our model and to review and justify the enhancements for retention and engagement.

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References


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