Concise paper

Artefact enhanced learning in introductory computing

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ABSTRACT

The early experiences of students are critical for both recruitment and retention. This paper examines the role of introductory programmes in facilitating recruitment levels for further study. We hypothesise that highly engaged students are more likely to remain committed to a path of study.

A model is developed that uses a project based approach to teaching introductory computing. The projects are designed to excite and engage while incorporating the learning outcomes of several formal papers. Assessment is accomplished via a matrix structure. Such a programme is currently being trialled. This paper discusses the approach and uses a mixed method of quantitative data and thematic analysis.

This approach has been highly successful. It is a synthesis of models rather than being entirely class based or, at the other end entirely experiential.

1. INTRODUCTION

The early experiences of students are critical for both recruitment and retention. This paper examines the role of introductory programmes in facilitating 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 way of a case study and then use this example to explore the approach.

2. CASE STUDY

An introductory programme plays a dual role. It needs to prepare students for further study (ie ensure core competencies are met) but also excite and engage the students so that they actually do progress to further study. This is a difficult mix. In six cycles of the Certificate in Information Technology (Level 4) at Otago Polytechnic the average programme completion rate is only 61.9% (cf an institutional rate in the 80s).

It is a sensible goal then to generate maximum interest, interactivity and attachment to the school so that students will progress their studies into the degree programme.

We decided to integrate the lab component of the foundation (Certificate in Computing Level 3) and CIT papers and utilise project based work to cover the course requirements. Lectures and theory content was aligned to the progress of the lab projects with assessment in a matrix structure (Figure 1). As most of the project work was constructed as group work most of the evaluation process was focused on theoretical knowledge.

2.1 Project 1

The lab work focused around three projects. For the first project the class was first introduced to the objective which was to control a cheap ($20.00) two channel remote control car using SMS text messaging (Figure 2). Once the class had an understanding of the objective an abstract solution was presented to them. Analyses of this abstract identified the technologies that where need to be used to meet the objective. Once identified, the technologies where explored with the objective of gaining sufficient understanding to pursue the project. This resulted in learning outcomes for networking (Cellular topography, Telephone infrastructure, TCP/IP, digital Packets and Frames…) micro controllers, 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)

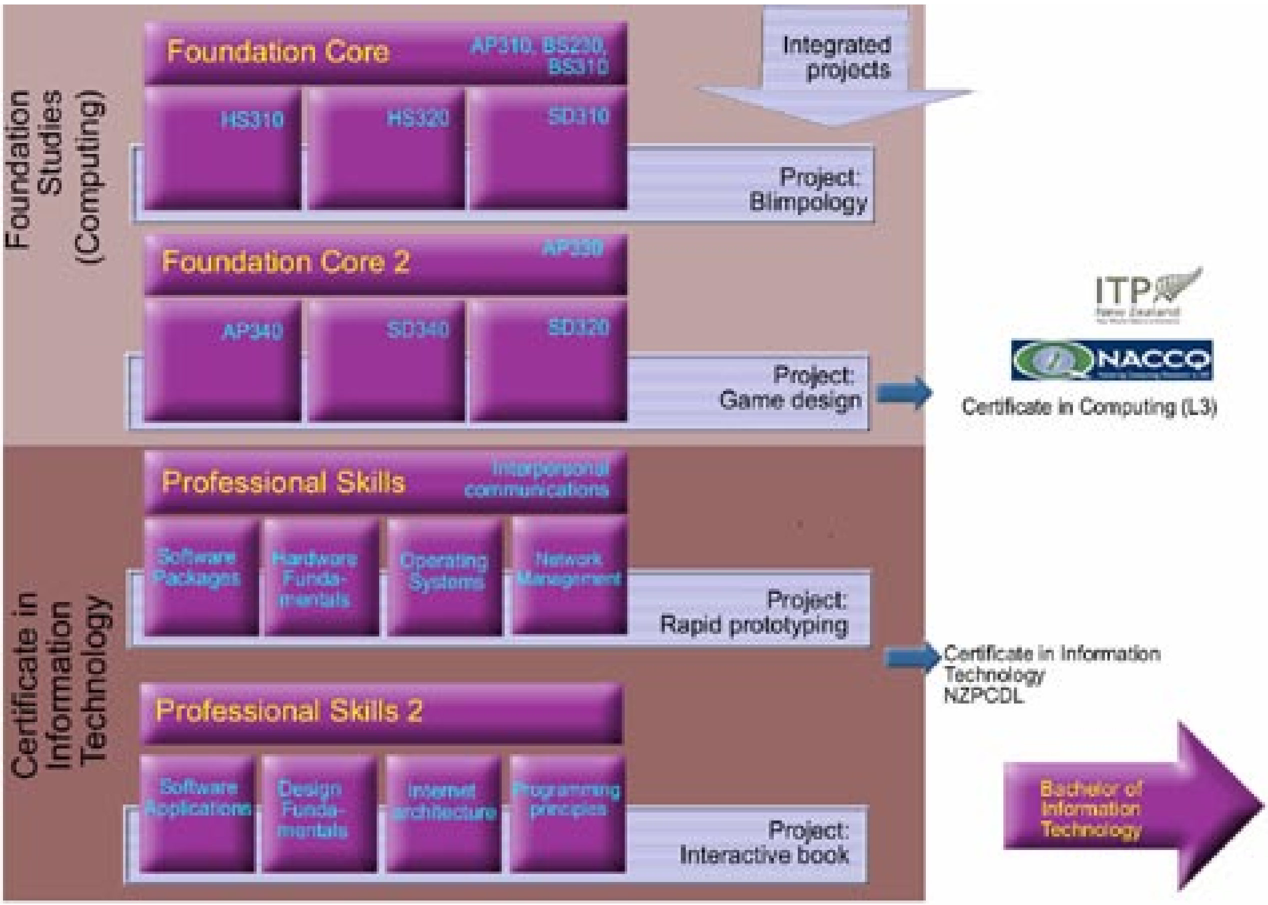

Figure 1: Integrated matrix assessment

We also needed to devise our own set of instructions for the user to micro controller interface used to activate movements of the model car.

2.2 Project 2

The second project was consistent with an introduction to Access Database and focused on the analysis of the database requirements, data input and editing forms stressing data validity and user access needs for accomplishing a given task.

2.3 Project 3

The third project was another micro controller focused one which required the student to devise a method of ordering coffee from the Student Centre using a laser light link. In this case they were encouraged to experiment and discuss the issues in groups before presenting their ideas to the class. We then consolidated the ideas, identified and the simplest solution. This was then divided back amongst the class for development resulting in a single prototype being built.

While this trial has only run one for one iteration, the results seem extremely promising. The historical 61.9% completion rate has dramatically improved to 96% (23/24). In the following section we examine a model that may give some direction as to reasons for this apparent success, and provide a vehicle for ongoing evaluation of this approach.

3. ARTEFACT ENHANCED LEARNING

The above discussion on the way some new courses are being taught at Otago Polytechnic rests in the theoretical framework of Artefact Enhanced Learning (AEL).

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. We have followed (Ch-

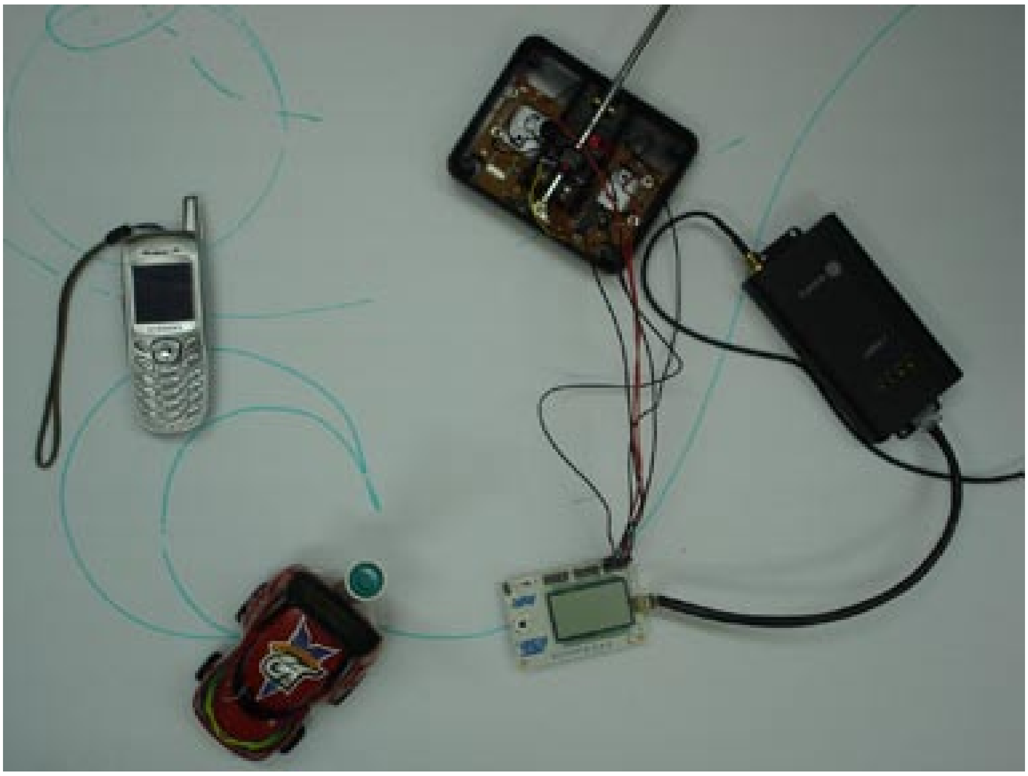

Figure 2: Components for Project 1 (clockwise from top left: cellphone, adapted remote control, cell receiver, ATMEL butterfly, remote control car).

ing et al, 2003) in broadening the concept of artefact to include 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 etc 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 similar 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 covey an expectation of minimal student movement and contribution. Ching (2004) were "amazed" that during student interviews concerned with lesson delivery ambient artefacts figures so prominently.

The final category of artefact 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.

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 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 difference ways.

6) AEL teachers know the subject area of the introduced artefacts.

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.

The final claim for the AEL model is that, whereas 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 for AEL.

2) Whereas the active-passive continuum leans towards participation, the teachers 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 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 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 unity in the near future. This, and the testing of claims made for an enhanced learning environment, will become the subject of future research. The team uses 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 (Wisconsin nd).

This approach has been highly successful. It is a synthesis of models rather than being entirely class based or, at the other end entirely experiential.

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