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Abstract

A challenge exists in designing and teaching a foundation technical course for a university Information Systems programme. It is not a computer science course and requires appropriate positioning in the IS domain. Through a series of iterations, and through the introduction of a number of interventions, a course was developed which embraces Chickering and Gamson's (1991) seven principles of good educational practice in undergraduate education. The outcomes are positive: students are less intimidated and more motivated; increased attendance of classes and lab workshops, improved pass rate; greater retention of students into second year papers; more motivated lecturers and tutors; and increased requests to become tutors.

Keywords: Teaching interventions, Systems development, Teaching IS, Good educational practice

Introduction

Many university courses contain practical as well as theoretical components: geography, business, and medicine, for example. The discipline of Information Systems (IS) relies on students having an understanding of the fundamentals of Information Technology (IT) as well as practical and applicable appreciation of business concepts. In effect, the discipline of IS teaches students about the nexus between people, organisations and technology. While IT is not the only component of an IS degree, it is integral to students' understanding of the discipline and they require core technical competencies in order to advance through an IS degree. However, not all students are keen on, interested in, or motivated to be involved with such elements of core courses in IS. Victoria University of Wellingtons undergraduate IS program has two foundation 100 level papers: INFO101 on the foundations of IS, and INFO102 which is an introduction to IS development practice. Both are required courses for all IS and Electronic Commerce (ELCM) majors at Victoria University. INFO102 is the prerequisite course for the technical stream of the IS major, the other stream which focuses on management, requires INFO101 only.

INFO102 is a large course. It introduces students to core technical competencies and develops basic development skills, and until recently was taught using delivery methods such as lecturing, self-paced and supervised workshops, and one 'capstone' end-of-term project. The course initially shadowed somewhat the more traditional computer science (CS) introduction to algorithms and data structures papers in concert with data and process modelling activities.

However, the initial offerings of INFO102 in 2004 were marred by poor student attendance of lectures; minimal student participation in lectures; lots of plagiarism – especially in the large end-of-term assignment; lack-lustre student performance in that assignment; a low pass rate; and low retention of knowledge to subsequent years' courses.

The question thus arose of how to design and present a technical foundation course in IS in such a way that the students were enthused and enabled to succeed in, and reap the benefits of such a course, and be inspired to continue their studies in IS.

We took the time to ask ourselves if there is a better way to deliver this course. The course teaching team began to introduce some key teaching and assessment interventions under the aegis of continuous improvement. Over six iterations of the course, a number of innovative interventions have been introduced which has transformed staff and student motivation. Chickering and Gamson (1991) provided us with a best-practice framework that we have used to guide and assess the value to the course of the interventions.

This paper describes those interventions and reports an improvement in student attendance, higher and deeper student engagement in class activities, improved performance in assessment, and greater retention of students in the second year of the degree. First, however, an overview of the literature is provided which identifies the basis of the approach taken.

Literature Review

Before embarking on the changes, the main challenge was to determine what constituted good educational practice at undergraduate level and to be guided by any such principles where appropriate.

One of the seminal works on undergraduate education is that of Chickering and Gamson (1991). They studied over 50 years' worth of research on the way in which researchers teach and students learn. From their research they developed a set of seven principles of good practice in undergraduate education (Chickering & Gamson, 1987). These principles were published in 1991, and became a huge success with hundred of thousands of copies of their book being bought in the US, Canada, the UK and throughout the world (Gamson, 1991). Many programmes implemented the principles and reported positively on the outcomes. For instance, Page and Mukherjee (2000) reported that student apathy towards academics reduced considerably, there was greater involvement in the course, and attendance and attentiveness increased.

As technology became more and more prominent in education as a means of delivering lectures and fostering collaboration, so attention swung all the more to examining how the seven principles could be implemented using technology as a lever. The following sections expand on each of the principles and how the use of technology, and often the Internet, has contributed to their successful implementation.

Good practice encourages contact between students and faculty

Frequent and regular contact between students and faculty both inside the classroom and outside is one of the most important aspects of students' motivation and involvement (Chickering & Gamson, 1991). Chickering and Gamson (1987) found that by working with others, students' involvement in learning increased. This is particularly true with regard to students and faculty working together, and relationships that they might further develop outside the classroom can form part of the teaching and impact even more on the students' learning experience (Wilson et al., 1975). However, Pascarella (1980) noted that factors such as student initiative, class size, classroom experience, and institutional size, structure and policy can affect the extent and quality of the student-faculty contact.

Internet technology based interaction with students is now commonplace. Technologies such as email, online learning environments, websites, discussion forums, and wikis all provide opportunities for student-faculty contact. Chickering and Ehrmann (1996) and Rudenstine (1997) all found that such technologies are very positive, and that e-mail has a particularly strong influence. Chickering and Gamson (2001) emphasized how typical conversation comprised a three-step sequence - instruction, response and feedback which could be very stultifying. Having a variety of Internet technologies in addition to e-mail can improve the chance of an appropriate communication channel being available, thereby enhancing the student-faculty interaction and relationship. This can even help to overcome some cultural barriers (Chickering & Gamson, 2001).

Good practice develops reciprocity and cooperation among students

Chickering and Gamson (1991) emphasized the importance of team effort in good education. This type of cooperative learning is characterized by five elements: positive interdependence, face-to-face interaction, personal responsibility, collaborative skills, and group processing (Johnson, Johnson & Smith, 1990).

Technology can dramatically strengthen such cooperation among students. These types of communication tools can have a positive impact on study groups, collaborative learning, group problem solving, and discussion of assignments (Chickering & Gamson, 2001).

Good practice uses action learning techniques

Independent study was viewed by McKeachie, Pintrich, Lin, Smith (1986) as a highly effective way of encouraging students to become involved in their own learning, and to take an active responsibility for it. They need to discuss what they're learning, relate it to past experiences, reflect on it, write about their reflections, and apply it to everyday situations (Chickering & Gamson, 2001).

Technology provides an opportunity for students to work at their own pace, to linger on aspects they feel need more attention, and move quickly through familiar material (Cates, 1992). This type of active learning are a means of giving students control of their own progress, and places the responsibility for their learning and maintaining focus and commitment, on them (Ritter & Lemke, 2000). However, Browne and Funnell (1998) sounded a cautionary note and that was that although this type of learning places more responsibility on the students, not all of them are sufficiently committed to their own learning to perform well with this sort of approach. It thus needs to be supported by the application of the other principles.

Good practice gives prompt feedback

An important aspect of learning is to be aware of what you don't know. This will focus leaning (Chickering & Gamson, 1991). However, students often need help initially in assessing their existing knowledge (Chickering & Gamson, 2001). One way in which this can be effected is by faculty providing timely feedback and the opportunity for regular practice (Cross, 1987; Dunkin, 1986; McKeachie, Pintrich, Lin, Smith, 1986).

This type of feedback and critical observations can be made even more effective by the use of technology (Chickering & Gamson, 2001).

Good practice emphasizes time on task

There is strong empirical evidence that time allocation, time management, and time spent on a job directly impact student achievement (Berliner, 1984). In addition, time efficiency increases when there are interactions, and when time is coupled with energy, learning is the result (Chickering & Gamson, 2001).

Technologies can improve time on task significantly (Chickering & Gamson, 2001). The Internet allows students to learn whenever and wherever they might be, so that their learning does not stop when they leave the classroom. Furthermore, the Internet access enables them to download preparatory material for their classes. (Ritter & Lemke (2000).

Good practice communicates high expectations

It has been empirically demonstrated that, all things being equal, students rate courses which they perceive as difficult and requiring hard work more highly than those they perceive as easy (Cashin, 1988). This is supported by Chickering and Gamson's (2001) view that the more you expect of a student, the more you will get. They found that expectations can also be raised by encouraging students to publish their work.

Good practice respects diverse talents and ways of learning

Although is a generally accepted notion that students learn differently, the concept of 'learning style' has been difficult to define and even more difficult to assess in terms of its impact on teaching practices (Evans & Sadler-Smith, 2006; Cassidy; 2004; Stark, Shaw & Lowther, 1989; Claxton & Murrell, 1987). However, it is realized that students need opportunities to demonstrate their talents and use their preferred learning style (Evans & Waring, 2006; Drysdale, Ross and Schulz, 2001; Chickering & Gamson, 2001)

When implemented together, these principles make use of six powerful forces in education: activity, cooperation, diversity, expectations, interaction and responsibility (Chickering & Gamson, 1991). For them to be effective, though, the environment in which they are implemented needs to possess the following qualities: a strong sense of shared purpose; concrete support from administrators and faculty leaders; adequate funding appropriate for the purposes; and continuing review of how well the purposes are being achieved (Chickering & Gamson, 1991). Barriers to successful application of the principles include institutional inertia which develops from traditional socialization, institutional structures and rewards, inadequate information and fear of the unknown (Chickering, 1991).

Method

Guided by Chickering and Gamson's (1991) seven principles, a series of interventions were embarked upon over a period of three years. Often the process of intervention was reactive. Over time, though, a more proactive approach has been possible.

The interventions followed three main directions. Firstly, they aligned the course more clearly with an IS context by introducing individual and organisational development team practices into the course schedule. In other words, they addressed the *'why we build programs'* aspects as well as *'how we build programs'*. Secondly, the interventions sought to improve student engagement and success through improvements in instructional practice. Thirdly, the interventions sought to *'practice what we preach'* by maximising the use of IS technologies where pedagogically appropriate.

In undertaking a programme of interventions aimed at improving overall performance of the course the first thing to be addressed was that of management buy-in. A series of meetings were held where the ground rules were agreed. The management message was that it was considered desirable to achieve a high pass rate (in the order of 80%) while at the same time achieving reliable competency for students moving into 200 level papers. It was also flagged as undesirable for the paper to act merely as a 'filter' to sieve through only those students that had the 'right stuff' for entry into the professional software development courses. Instead, the open entry INFO102 course should be providing a 'sampler' of the analysis and development phases of the systems development life cycle. That introduction should enable understanding of the issues surrounding modern analysis and development practices even for those who did not wish to continue with an IS major. This effectively meant that there was to be a quality bar set at a level which satisfied the prerequisites for courses which followed on from INFO102. It would fall to the teaching team to bring most of the class over that bar.

Using Chickering and Gamson's (1991) seven principles of good teaching practice, the INFO102 management approach is summarised in the following table:

Table 1 - management qualities for effective intervention programmes

A strong sense of shared purpose	A consistent core teaching team of 2 lecturers, 1 lab instructor and a course manager was used in additional to sessional tutors.
Concrete support from administrators and faculty leaders	A clear management commitment to the interventions from the head of school and undergraduate programme director levels was received. Commitment to fund a high pass rate and high quality.
Adequate funding appropriate for the purposes	Additional resources funded: lab instructor, technical support and tutor/marker time was made available.
Continuing review of how well the purposes are being achieved	Management support given for internal empirical research and participation in a longitudinal multi-university intervention study.

Interventions

In summary, 2004 was our 'annus horribilis' with a low of 13 students (out of 200) attending a mid-term lecture. The timeline for the intervention (See Table 2) was driven out of a desire to quickly and effectively address a clear performance issue.

Table 2 - Timeline of INFO102 Interventions

	Trimester 2 2004	Trimester 3 2004	Trimester 2 2005	Trimester 3 2005	Trimester 2 2006	Trimester 3 2006
Intervention	Deliver programming instruction in lectures. Self-paced workshops with supervisors helping. Large project handed-in at end of term.	Small changes to traditional model - of limited value for addressing issues.	**Instructor-led workshops introduced.** **Lectures refocused** to an IS context Used self-paced materials, supplemented with instructor briefings	**New workshop materials** developed to suit instructor-led approach. In-lab **marking by software inspection** of single project introduced.	Workshop materials further refined. Introduced **staged marking of project.** Applying lessons learned to data and process modelling parts of the course. Shift from project assignments to **mastery tests** with strong tutor involve-ment	Use of pre developed **video material** for self paced support **Introduction of Wiki**-based knowledge base to transfer student developed material between course iterations
Problems	Low engagement (poor lecture attendance and participation) Lots of plagiarism in project assignment (sign of desperation) Poor retention of knowledge to subsequent years courses (un-reinforced learning) Low pass rates		Problems getting workshop teaching synchronised with the project.	Problems with marking a single project in a tight timeframe - doesn't scale well.	Problems with plagiarism in first half of course.	Problems with knowledge transfer across iterations of the course

Note. The authors recognise that the problems identified may have been symptoms of deeper problems and potentially have ambiguous root-causes. However, as in any continuous improvement strategy, it was necessary to move forward with the analysis at hand.

Table 2a - mapping the problems onto the interventions

Problem	Intervention
Low engagement	Use of relevant IS examples In-lab video materials Discussion boards Wiki Workshop 'buddy' system
High plagiarism	In-lab marking by software inspection
Poor knowledge retention	Management of the topic scope (doing a smaller number of topics well). Use of relevant IS examples.
Low pass rate	Instructor-led workshops - involved a management commitment to keeping a 'high bar' and higher resource levels.
Synchronised teaching/assessments	In-lab marking, Staged assignments
Lack of timely feedback	Staged assignments (fast feedback)
Knowledge transfer across course instances	Wiki knowledge base

All the interventions described in Table 2a have been retained for subsequent instances of the course. To that extent, they are regarded as successes. The ongoing measurement of the degree of success is the subject of a further study currently underway.

Applying the Seven Principles

The seven principles of good teaching practice serves as a useful frame of reference with which to categorize the interventions. In Table 3 below the IS context is matched with the seven principles to illustrate the motivation of each intervention.

Table 3 - IS contextualization and alignment with the '7 principles of effective teaching'

Intervention	**Using IS as a mechanism for effective teaching**	**Improving teaching of IS**	**Alignment with the 7 principles**
In lab video material	✓	✓	**3, 5, 7**
Providing monitored discussion forums	✓	✓	**1, 2, 3,7**
Instructor-led workshops		✓	**1, 2, 3, 4, 6, 7**
Workshop 'buddy' system		✓	**2, 3, 5, 7**
In-lab marking by software inspection		✓	**1, 4, 6, 7**
Wiki - knowledge base	✓	✓	**2, 5, 7**
Re-alignment away from CS1, CS2 style objectives into 'IS relevant' workshop materials		✓	**3, 6, 7**
Staged assignment delivery- focusing on mastery at each stage		✓	**3, 4, 6, 7**

Good practice encourages contact between students and faculty

As a result of management commitment to retaining a high quality bar and bringing more students successfully through the course the first initiative was a commitment to more contact time and a reworked instructor configuration. It was in the form of instructor-led workshops. These workshops were held in the school's purpose-built 50 seat lab, with dual projection screens and multimedia capability. In addition to the instructor-led workshops, topic-focused help desks were added and additional office hours and question time allowed during the twice weekly lecture programme. The lab instructor operates in addition to the course lecturers. The labs and lectures are closely aligned in the first two weeks of the programming section of the paper but gradually diverge as the lectures focus on the 'why organizations develop systems' topics and the labs focus on the 'how to build a (modest) system'. This split in focus is what situates this part of the course as an IS course and not a CS1-style introduction to algorithms and data structures.

Good practice develops reciprocity and cooperation among students

An important part of the role of the lab instructor is to 'facilitate' the more able students in assisting those students who 'don't get it' via an informal 'buddy' system. Two important provisos on this practice that need to be clearly communicated are: (i) that a 'buddy' system is in no way a substitute for the paid lab tutors - there are still 2 paid tutors, minimum, per 50 person lab, in addition to the lab-instructor - and (ii) that the 'buddy' system is entirely opt-in, there is no obligation for students to help others unless they want to. What we set out to do was to encourage behaviour that occurs naturally within 'engaged' groups.

The Blackboard online learning environment is used for running discussion forums for students. The discussion forums are structured with a three tier response protocol. Firstly, students are encouraged to attempt to answer each other's inquiries this is the peer response level; if a suitable response is not forthcoming or is incorrect then the second level is where the tutors answer the question. In practice, these two levels are where most discussion threads are concluded. Thirdly, if a thread remains unanswered the course instructors will intervene. Unfortunately many valuable answers contained in discussion board thread are lost when the course ends. To address this issue a Wiki has recently been introduced in an attempt to encourage knowledge transfer across multiple iterations of the course with questions of an enduring value being migrated to the Wiki. The Wiki is editable by staff and students equally. Although this has been active for only one summer iteration of the course, no abuse of the editing ability has occurred.

Good practice uses active learning techniques

The instructor-led workshops, lectures and tutorials all attempt to make use of active learning cycles, with opportunities to apply or simulate the programming concepts involved. For example the learning cycle of the lab sessions uses the following pattern:

Briefings - the lab instructor has a prepared instructional presentation that occupies no more than 20 minutes of the 2 hour class (and may be in several parts). *Concept checks* - the lab instructor uses several techniques such as quiz questions, colored response cards etc to carry out concept checks during the lab sessions. *Video demos* - in the most recent iteration of the course the lab instructor experimented with prepared video demonstrations of critical step-by-step actions that experience had shown students found difficult. Because students are able to replay the video descriptions as often as they wish this simple intervention was very well received among the students who found the material challenging. The self-paced workshop exercises form the core of the lab sessions and follow a similar pattern to the major assignment questions but with a mixture of fully and partially worked answers. The self paced material is reinforced by the in-lab tutors who are available on request. The Wiki is also aimed at reinforcing active learning by encouraging the more talented students to reflect on successful strategies and share their 'best practices'. The additional benefit of this approach is that it is also designed to mirror to some extent what happens in code review meetings and programming discussion boards in the professional setting.

Good practice gives prompt feedback

The large end-term project used in 2004 and 2005 was characterized by:

i. Poor student performance - unable to get their code 'working'
ii. The project was designed around designing problem solving algorithms and less on demonstrating understanding of IS concepts
iii. Many cases of plagiarism
iv.

Finding ways of resolving these symptoms was a primary goal of the initial interventions. The strategy that emerged was in two fundamental stages. Firstly, the project was broken into four smaller parts each building on the previous. Secondly, the marking of the project was conducted with the student, in the lab; where students may be called on to explain sections of their work - no prior indication of which sections are to be inspected is given.

Table 4 - Staged marking of the project assignment

	Task 1	Task 2	Task 3	Task 4
Week 7	Can be completed and marked			
Week 8		Can be completed and marked		
Week 9			Can be completed and marked	
Week 10	Model answer given			Can be completed and marked Model answer given on last teaching day
Week 11		Model answer given		
Week 12			Model answer given	

The model answers to the staged assignment are released on completion of the marking for each stage so that for subsequent stages a poor result in an early stage will not cause ripple through to later stages. Software inspection based marking mitigates the plagiarism because students will be called upon to explain their code in person. This approach has been so successful that in the latest version of the course a similar intervention has been trialled for assignments in data and process modelling. However, due to the limited amount of marking time available per student (in a class of 250) only minimal personal feedback was possible. This disadvantage was mitigated by consolidating the feedback and providing feedback at a group level, to review the current materials and delivery pace.

Good practice emphasizes Time-on-Task

The IS school labs are made available to enrolled INFO102 students on a 24 hour, 7 day per week basis. Lecturers and lab instructors encourage experimentation and the undertaking of small personal projects. Examples in lectures and labs are based on the instructors' own small projects. An ethos of experimentation and testing is promoted. When combined with the large number of practice exercises there is a wide range of opportunities for students to find a part of the material they can relate to and become engaged with. In order to fully address an introduction to systems development the course faces the ongoing dilemma faced by most applied commerce courses, in that students with no commercial experience are being exposed to concepts such as team practices and software engineering. Such practices are developed to suit organizational contexts that are culturally foreign to many first year students. The trade-off between building small-scale software projects to which students can relate and dealing with 'big picture' issues we hope means that engagement is not lost completely.

Good practice communicates high expectations

The interventions emphasize depth – the process is aimed at doing an achievable number of things well rather than developing a large ‘laundry list’ of concepts dealt with only superficially. The quality bar is not concealed from students and students who choose not to take up the many opportunities can, and do, still fail the course.

Good practice respects diverse talents and ways of learning

The staged assignment means that strong students can complete their project work by the end of week ten and less able students can legitimately use until the end of the term without penalty. The help desks take the “going over basics” out of scheduled class time so that students who are less confident can have an opportunity to address knowledge gaps without feeling intimidated by holding up the class. In addition, the tutor team is also selected to address a diverse mix of cultures, talents and learning styles so that a range of students needs can be accommodated.

Outcomes

Unlike topics such as mathematics, systems development has little preparatory base from secondary education for students to draw on. Our programme of interventions has produced less intimidated and in-turn more motivated students. This motivation has been evidenced by clear improvements in class and lab attendance and better overall student performance. Performance improvements take two forms: the pass rate for the course itself has improved and just as importantly the number of students being retained into 200 level papers has improved. A secondary effect is that the lecturing and tutoring teaching team overall is motivated and prepared to be innovative because of the successes to date. The powerful word-of-mouth undergraduate tutor network promotes INFO102 as one of the more desirable papers to be a tutor for, making recruiting and retaining talented tutors easier**.**

Conclusion

INFO102 is a course that teaches the technological fundamentals of systems development while still maintaining a clear IS focus situating the development of systems contextually with organisational and individual needs. Managing this essential duality fits in well with the overall aims and purpose of the Victoria IS undergraduate programme. Although the design and development of a course takes time, applying sound education principles benefits a course, irrespective of the discipline. In a series of interventions over a three year period, Chickering and Gamson’s (1991) seven principles of good practice in undergraduate education have guided a programme of continuous improvement interventions in a first year technical IS course, INFO102. The results have been very positive. Future interventions will seek to improve the course and the way in which it is offered still further**.** It is planned to conduct focus group interviews with the various years’ cohorts of students and tutors, and in-depth interviews with the relevant lecturers in order to further inform this progression.

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