

PRAGMATICS OF LEARNING

An Introduction to an Integron Methodology for Generating Learning Breakthroughs

Chris Lonsdale

Chris Lonsdale & Associates

clonsdale@superlearning-asia.com

&

Barbara Gorayska

Department of Computer Science

City University of Hong Kong

csgoray@cityu.edu.hk

**Technical Report TR-99-01
Department of Computer Science
City University of Hong Kong
September 1999**

Executive Summary

Pragmatics of Learning – Integron Methodology for Learning Breakthroughs

To enhance the process of learning and teaching at City University we have developed a new instructional methodology that we have chosen to call **Integron Teaching Methodology**. This methodology **integrates a range of different techniques** (e.g. accelerated learning methods; experiential learning methods; problem based learning, life long learning, etc.) into a **strategic learning process** that significantly enhances student's subject based learning, learning skills overall and their whole person development.

What is different about this methodology is not the individual elements, per se, but rather the way in which different aspects of the various methods for accelerating learning are fitted together to create the learner's *whole* learning environment – an environment that actuates *natural learning potentials* in people.

While there are a number of approaches to developing learning skills designed to aid whole person development, generally as a means to enhance the process of acquiring subject-based knowledge, we have *reversed the order* and used the process of acquiring a specific subject-based knowledge to aid the learner's whole person development.

The Integron Methodology is thus a subtle but profound paradigm shift. The paradigmatic change results from a shift in emphasis vis-à-vis the totality of the learner's learning experience. This particular shift relates to the conceptual model underlying the view of learning, which is seen as a *natural organic process*, and the *nature* of focus upon the learner. Learner interaction modules - Integrons - that make up the curriculum, naturally build learners' knowledge, draw out learner's understanding, and generate their meta-cognitive transformations.

In 1999 this methodology was tested in twenty eight contact hours with second year students learning Human Computer Interface design (HCI). In testing the Integron Teaching Methodology we were able to achieve the following outcomes:

- In final year exams, students exposed to the Integron methodology performed significantly better than students from previous years. This increase came despite a one-third decrease in teacher contact time.
- Using a pre and post-test method of comparison, 15 percent of the students exposed to the Integron Teaching Methodology were able to demonstrate a significant qualitative shift in their thinking orientation towards the HCI course material. This compared with only a 3 percent shift in a different student cohort not exposed to the Integron Teaching Methodology.

There were also many obvious qualitative shifts.

The success of the Integron Teaching Methodology comes from: the way it optimizes learning by a holographic organization of learning stimuli that “instruct” at the level of the presupposed; attention to the relationship between unconscious and conscious processing of information; its multiple feedback loops; shared immersive experiences that ground abstract language symbols that it provides; and its carefully designed-in, subtle distortions of the familiar as the source of motivating, cognitive dissonance and thus as the basis for cognitive, creative leaps.

In this methodology CONTENT is seen as secondary to PROCESS, and the major goal is to get individuals fully engaged in their own learning. Once this has been achieved, content is acquired relatively easily.

ACKNOWLEDGMENTS

The research reported here has been generously supported by the City University of Hong Kong from two funds: the Teaching Development Grant and the Quality Enhancement Fund.

We wish to express our gratitude to Professor Edmond Ko, Professor N V Balasubramanian, Professor Horace Ip and all members of the two Funding Committees for their encouragement and constructive comments on the direction we took as well as the way we executed our research.

We also want to thank Adeline Lau from the Professional Development and Quality Services of the City University of Hong Kong and Anthea Chan from Chris Lonsdale & Associates for taking care of all the details that lubricate the process of any good project.

Thank is also due to all members of staff in the Computer Science Laboratory, the Facilities Management Office, the General Office of the Computer Science Department who gave prompt and professional assistance whenever it was needed, and to the two students from the Department of Computer Science: Wing Yuen and Penny Kwong , who helped develop and maintain the supporting Web sites.

We also take this opportunity to thank our cohorts of learners for their eager participation, creative thoughts, and many moments of joy that they brought to this project.

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Section 1

INTRODUCTION TO A NEW LEARNING METHODOLOGY

“Time goes quickly, the HCI course will finish soon. Looking back I discover that I’ve improved a lot about HCI. It is difficult to tell what totally new things I have learnt, one by one. Rather, I’d say my way of thinking, observing and learning is changed. ... [T]his unusual course also made me have unusual improvements.”

Lee Ka Chun Kenneth

Numerous techniques that are intended to facilitate and accelerate learning have been developed and tested around the world during the last 20 years. In this report we introduce an Integron Methodology we have developed that incorporates a selection of the most appropriate of these techniques as they are applied within the larger context of tertiary education in Hong Kong. The methodology also embeds within an even broader spectrum of the learner’s whole person development.

The methodology was developed while we were teaching the Human Computer Interface Course for year two students at the department of Computer Science of the City University of Hong Kong.

This report provides the rationale for the new approach, the guidelines that can be used by other course designers and teachers at the City University to build holistic techniques into their own teaching, and our evaluation of the effectiveness of the Integron Methodology within the Hong Kong tertiary education system.

Our thesis has been a simple one. Research into facilitating and accelerating learning that has been carried out over the last two decades has led us to believe that tertiary level learners can learn more, faster, and to a deeper level than is commonly observed within education today. This can, however, only happen if their *whole* learning environment is carefully designed in a way that actuates *natural learning potentials* in people.

This paper outlines the initial thinking and practice underlying our development of the Integron Methodology.

1.1 Current Approaches to Learning

1.1.1 Conceptualisations of Learning

Learning has been conceived in many different ways. In the literature on educational approaches, three different major lines of thought are evident. For instance, learning is thought of as a development of cognitive structures (i.e. patterns in mental and physical activity that underlie manifest intelligent behaviour¹)

Learning has also been conceived of as being essentially, and necessarily, a product of social interaction². And it has been looked at from the perspective of an interaction between an individual and his or her environment.³

While individual approaches to learning and curricula usually consider all three interdependent elements: cognition, (inter)action and context, they vary in the emphasis given to each of these according to the adopted theoretical framework.

Individual approaches and curricula can be further differentiated with respect to which perspective they take on what constitutes a cognitive structure, on what types of relationships exist between social interaction and cognitive process, or on the nature of environments that humans interact with as well as the modes of, and tools for mediating, such interaction.⁴

For instance, recently much attention has been given within the education technology community to facilitating learning by either immersing learners within a set of relevant, shared experiences that lead to conscious self-reflection (experiential learning approach⁵) or by modifying curricula to comprise authentic, ill-structured, case studies where judgements and prioritisation of what is problematic in situations can be practised (problem based learning approach⁶).

¹ Piaget (1970).

² Social Development Theory. Vygotsky (1962, 1978).

³ Behaviourism, Gestalt and ecological approaches, etc. Wertheimer, M (1959); Ellis, W.D. (1938); Koffka (1935)

⁴ Specific variations in curricula and approach to learning will not be discussed in detail here. A comprehensive account of theory and practice can be found in the Theory into Practice (TIP) database (Kearsley, accessed 1999).

⁵ The origins of this approach can be traced to the Experiential Learning Theory of Rogers (1969).

⁶ Elstein, Shukman & Sprafka (1978), Barrows and Tamblyn (1980); Margetson (1991); Boud and Feletti (1991).

In a related approach, learners learn from tasks and activities which they are asked to do (learning by doing approach⁷) and learning contexts are created which encourage them to formulate good questions (questioning perspective approach⁸.)

These approaches accord with the view that both human knowledge and human cognition are distributed, socially shared and situated.⁹ Learners are taken away from the traditional, highly structured, didactic, classrooms, where their knowing about themselves and the world is passively instructed to them, into real-life (like), empirical, dynamic, socio-cultural settings where they themselves can construct¹⁰ relevant knowledge by enquiring, acting, playing and interacting.

Related approaches that integrate many of the above perspectives include NLP (neuro-linguistic programming) and various accelerated learning methodologies. These have focussed a little less on the social aspects of constructing knowledge and much more on a *direct* coupling between the features in a learning environment and the mental states of learners that accelerate learning. For example, within the field of suggestopedia, developed by Georgi Lozanov and his colleagues, the emphasis has been on generating relaxed mind states in the learner. These are believed to enhance long term memory and non-conscious, factual knowledge uptake¹¹.

As stated by Lozanov and Gateva,¹² “the suggestopedic method (in it’s present-day phase) results in an acceleration of learning, a laying of the foundation of the foreign language, and a creation of possibilities to make active use of the material which consist of about 2,000 lexical items and the whole basic grammar.”

Neuro-Linguistic Programming (NLP)¹³ has concentrated predominantly on how perceptual modalities (auditory, visual, kinaesthetic and linguistic) can be reorganised and restructured in a learner to facilitate mastery of mental and physical skills. Within the NLP model, the medium of interaction between a learner and a learning facilitator consists mostly of carefully crafted natural language interaction.

⁷ Lemke (1993); Kass and Hermann (1999).

⁸ Questioning Perspective Approach Gorayska and Marsh (1999). cf. Shank and Jona (1990);

⁹ Lave & Wenger (1990); Suchman (1985). For the origins and contributors see Salomon (1996).

¹⁰ This approach follows the theory of learning known as Constructivism (Bruner, 1960 & 1990).

¹¹ Suggestive accelerated learning approach. This approach uses tools such as music, positive suggestion, and structured “learning rituals”. Lozanov (1978); Rose (1985); Rose and Nicholl (1998). This methodology has been most successful in learning foreign languages.

¹² Lozanov and Gateva (1988: 19)

¹³ Bandler and Grinder (1979); O’Connor and Seymour (1990); Andreas and Faulkner (1996). NLP also makes an extensive use of the Milton Model developed for hypnotic therapy by Milton Erickson. Bandler and Grinder (1975)

1. 1. 2 The Focus of Teaching

A different way of viewing the educational process is to look at the outcomes that teachers and programmes are driving towards. A distinction can be drawn between approaches that focus on learning within particular knowledge disciplines, those that focus on developing particular cognitive skills, and those that focus solely on personal development of the learner.

Examples of the focus on discipline are an attempt to facilitate learning of medicine¹⁴ or an attempt to facilitate learning how to solve mathematical applications problems.¹⁵

An example of the focus on a single cognitive skill is an attempt to design classes that facilitate creative thinking to the exclusion of other cognitive skills.¹⁶

An example of the focus on personal development is the recently launched Whole Person Development 2000 program at the City University of Hong Kong. This program aims at helping learners develop spiritually, intellectually, physically, socially, emotionally, aesthetically, and make progress in their career life, through active participation in numerous extra-curricula workshops and retreats¹⁷.

¹⁴ Elstein, Shukman & Sprafka (1978); Barrows and Tamblyn (1980); Barrows (1986).

¹⁵ See, for instance, an experiment in secondary schools in Belgium (Verschaffel et al, 1999) and the references therein.

¹⁶ Examples include, among others, De Bono (1967); Guilford (1986); Creative Problem Solving Model (CPS) of Osborn (1953) and Parnes (1967).

¹⁷ Program proposal by the Advisory Committee of the Student Development Services at the City University of Hong Kong, 1997:5-6. The elements of developmental growth are defined as follows:

- *spiritual* (beliefs, values, moral and ethical judgments, commitment to service the community),
- *intellectual* (ability to think, question and evaluate as well as acquire, process and use information, creativity, learning from experience and solving problems),
- *physical* (ability to behave to enhance one's fitness: balanced diet, time management, exercising, etc.),
- *social* (ability to integrate and perform one's social roles effectively and harmoniously: establishing relations with others, organizing support networks, having respect for individual differences and diversity in cultures),
- *aesthetic* (ability to participate in artistic activities, appreciate arts, beauty and nature or foster peaceful temperament),
- *career* (ability to identify one's career choices, develop career plans, etc.)
- *emotional* (ability to recognize, express, and manage one's emotions).

For us a danger of extra-curricular activities such as the above that promote individuated subsets of cognitive skills or “personal development” is in their remedial flare: the implication they carry is that at the time of enrolment those particular skills are somehow lacking in the participants.

1. 1. 3 Life Long Learning

Within educational technology the case has also been made for fostering *life long learning* rather than merely aiding learners to acquire state-of-the-art, discipline related, problem solving skills¹⁸. This approach excludes spontaneous, day to day, often non-conscious learning that happens in every-day life, which we will return to later. Instead, it follows the widely accepted custom and addresses only intentional, deliberate, goal-based, learning that helps retain what is learnt for a considerable period of time¹⁹. Proponents of life long learning call for learning to be active, informal, integrating and integrated, and to result from applying a variety of learning strategies to real life problems. Links between vocational and general education are highly advocated, such that learners do not only remember what they have learnt but also retain a planned-learning habit throughout their post schooling life.

1. 2 An Integrating Approach – The Integron Methodology

It has been said that there is nothing new under the sun. The Integron Methodology we have developed in the course of this project draws upon thinking from many of the above mentioned approaches, and applies a range of techniques that, in and of themselves, are not new. The merits of the Integron Methodology, therefore, are not limited and ought not to be sought in the nature per se of the specific techniques we have used on this particular occasion. What is different about this methodology is the way in which various aspects of the various methods for accelerating learning have been selected and structured, i.e. in the way the learning process is integrated and the way the different elements are fitted together to help learners undergo the type of transformations of learner states we had intended for them at the outset.

¹⁸ Knapper and Cropley (1985).

¹⁹ Knapper and Cropley (1985:20).

Our hypotheses have been:

- that careful design of the *whole* learning environment in a way which actuates natural learning potentials in people can lead to significant and measurable improvements in learning and to development of the learner as a whole person and,
- that a true focus on the learner rather than on teaching and on teaching tools, can further help actuate learning potentials.

To this end during the course of this project we have focussed on a number of different elements of the learning process.

Firstly, we have explored the best ways to set up and work with an effective environment that can significantly enhance learner creativity and desire for self-learning.

Secondly, we have examined different ways such an environment can be effectively fabricated for a specific subject, namely, human-computer interface design (HCI). The focus here has been on helping learners to more rapidly acquire factual information and also more rapidly and easily master new, practical, designer skills.

Thirdly, we used the HCI theory and the practical designer skills, that our learners were acquiring, as mental tools to help them develop and enhance general cognitive skills that appear to underlie learning and creativity in general. Elements that we focussed on mostly were the power of observing, attending to feedback, creating, reasoning and the ability to control affects (emotional states).

Fourthly, and most importantly, we used general cognitive skills, and metacognitive skills such as reflection, as a set of mental tools to help the learners better integrate emotionally, intellectually, physically and socially.

While other approaches to developing learning skills tend to aid whole person development as a means to enhance the process of acquiring subject-based knowledge, we have *reversed the order* and used the process of acquiring a specific subject-based knowledge to aid the learner's whole person development.

An integral part of the project has been the design, integration, application and testing of specific, situated tasks and activities that accelerate the uptake of new, discipline oriented skills and information by the learners and that simultaneously, *as a matter-of-course*, lead to the learner's whole person development and development of life long learning

habits. We also believe that the (meta)cognitive developments have themselves been accelerated because they have been integrated into the very fabric of learning during the core university HCI courses.

We are now beginning to believe that the Integron Methodology is a subtle but profound paradigm shift. The paradigmatic change results from a shift in emphasis vis-à-vis the totality of the learner's learning experience. This particular shift relates to *the nature* of focus upon the learner.

When a person *really* learns something (here we refer to the process of natural learning) then they will transform at some level because real learning engages the continuum of the brain, the body and the world.²⁰ We also believe that natural learning results in knowledge that is predominantly tacit, and often difficult to verbalise or linearise. Therefore, in order to craft learning environments that actuate natural learning potentials in people and that in turn lead to natural learning, it is important to address the issue of how the whole range of different technologies available for use in different approaches to learning can, and will, impact positively or negatively *the process* of actuating such learning potentials.

What we mean by technology is very broad. It includes obvious mechanical gadgets and computer related media devices for delivering digitised information. It also includes natural language, pictorial language, auditory compositions, or even mental process such as metaphor when used as a tool for generating new ideas. For us technology is thus any structured physical or mental construct that can filter, empower or inhibit, thus control, behaviour and cognitive development in humans.

If a technology exists, and if it is readily available, people will use it. It is relatively easy to use an available resource technology simply because it is there. What is not so easy is to use the appropriate resource technology at the appropriate time and to the appropriate extent, which is the crux of interfacing. In order to directly interface the learning process, it has been essential, therefore, that we paid attention to the affordance potential inherent in the educational technologies concerned.²¹

²⁰ Further discussion of this continuum can be found in Clark (1997).

²¹ Gorayska and Marsh (1999). Whether a given technology is or is not appropriate appears to depend on a degree of cognitive fit (Vessey and Galletta, 1991) between mental processes engaged by a given technology and the demands on that engagement by specific cognitive (learning) tasks.

Particular technological factors that we chose to consider in crafting the environment in which we interfaced and coached the holistic development of learners were:

- Psychological priming of the students to facilitate rapid and easy uptake of new information
- The structured use of language to generate mental states conducive to learning
- The use of physical metaphors and story based metaphors
- The design of specific experiences that can activate new questions and learner curiosity
- Paced presentation of the material to be learned so as to facilitate uptake by Long Term Memory
- The appropriate use of music to vary relaxed and alert learner states
- The appropriate use of different perceptual modalities to enhance interaction between different learner metacognitive processes²²
- Different media and Web-based technologies for disseminating digitised information of the course content.

The methodological question was ‘When, why and how is best to combine them?’ In this context there have been two possible approaches we could take. We could either fit the learners to the demands of the tools or fit the tools to the learning demands of the learners.

1. 2. 1 Fitting Learners into the “Box”

A great deal of effort these days goes into how one can best use modern multimedia and Web-based technology for educational purposes. The underlying strategic thinking that runs through such endeavours appears to be ‘Here’s the technology, what can we do with it (in education)?’.

For instance, a lot of research is currently being done to further our understanding of how learners use computers in their working and leisure time so that we can create educational software that is entertaining and fits naturally and effortlessly into their already developed behavioural and cognitive habits.

We believe that this kind of methodological approach, whereby one tailors learning and teaching problems to fit the existing use of tools, may not be appropriate or effective in helping learners restructure, enhance and speed up their multidimensional growth.²³

²² These may involve eight types of intelligence postulated by Gardner (1993).

²³ For example, an extensive use of Web technology has been found addictive (Turkle, 1996) but its unbounded and loosely structured organisation can be prosthetic in some cases of inborn cognitive impairment such as autism (Grandin, 1997).

For example, it is now extremely popular to encourage learners at the secondary and tertiary levels of education to communicate with both the learning facilitator and other learners using e-mail and the Internet. Some newly developed applications include ICQ, Web Quizzes, or News Boards, etc.. In some sense such facilities are an advantage, partly because they help shy learners and overworked staff to get in contact with the rest of the learning community.

However, the pragmatic process of communicating via such media differs from the face to face communication in at least one fundamental respect: namely, it frees the participants from having to deal with the immediate consequences of the interaction, especially on a more personal level.²⁴ In face to face communication rejections are easier to detect (due to visual cues in body language²⁵) and more difficult to accommodate. Eliminating the necessity of dealing with these situational factors is undesirable in instructional contexts that aim at the holistic development of learners.

When selecting instructional tools, therefore, we asked instead ‘What is the real learner need and which technologies can best support it?’. This question branches off into a number of related questions that always come to the fore when approaches to learning are concerned: ‘How and why do people learn?’, ‘What is the pedagogy each individual technology is designed to support?’, ‘What do we intend for our students to learn?’, and ‘Which technology or a combination of technologies shall we use or develop to facilitate this (type of) learning?’

1. 2. 2 An Organic View of Learning

We see learning as a necessary precondition for survival of any living organism in an ever-changing dynamic world. In everyday life people learn continually and effortlessly. It is often enough for them to experience things once and remember them all their lives. When an individual is part of ‘real life’, acquiring this type of knowledge is intrinsically motivated.

By contrast, institutionalised learning (from the learner’s point of view) is harder, requires a lot of support resources, and does not command the learned material to memory with an equal ease for an equally long time. The question is ‘why?’.

²⁴ Good (1996).

²⁵ For more detailed account of the importance of body language to communicating see Gill et al (1999).

In designing Integrons we looked at the influence of learning environments, both mental and physical, on the ease with which people learn. Many obvious differences, such as sensory deprivation in the learning environment that prohibits mental growth or extrinsic learner motivation by the society and the learning institutions themselves that often leads to inattention, have already been noticed, explored and exploited in ways similar to ours within the current approaches to learning discussed earlier.

One most striking discrepancy between the two types of learning, which we chose to attend to, and exploit, differently in this study, is that in learning institutions people approach learning as a conscious task while in real life people frequently learn non-consciously and in spite of themselves.

If living organisms continually (re)integrate and generate change and growth, i.e. learn holistically, in order to accelerate learning holistically we need to create contexts that speed up and support this natural organic process. Or, put in other words, to make it easy for people to learn, and to learn how to learn, we need a new, unified pedagogy that models, fosters, impacts, actuates and therefore best suits, the natural, predominantly non-conscious, organic process by which humans integrate (both bodies and brains) with their socio-physical environment.²⁶ The Integron Methodology proposed here is designed to contribute to the fulfilment of this need.

What is important about this methodology is the conceptual model underlying the view of learning, and the criteria for selecting and designing “learner interaction modules”. In the following sections we outline the *process* by which the Integron Methodology operates in terms of the selection and application of appropriate teaching tools.

A final issue that must be taken into consideration is the strategic nature of the Integron Methodology. It is strategic in the sense that specific goals are set, and actions taken to achieve these goals. The focus of the strategy is to enhance the natural learning process itself and the metaskills of the learner as a person competent to learn rather than stress any particular content. *Content is embedded within the process*, and it is at the same time secondary to activities designed to support the development of (meta)cognitive skills.

²⁶ One example of a technique with which this can be done comes from the experience of teaching deaf, dumb and blind from birth children in Zagorsk near Moscow. What has been found effective in actuating a natural learning potential in those children was the use of partially familiar object in order to excite the child’s interest. The children remained indifferent and inattentive if the objects introduced were totally unfamiliar. (Levitin, 1979, quoted in Webster, 1994).

This contrasts with many currently available learning models which focus much more on the content to be learned, the apparent assumption being that all learners come armed with the best learning strategies.

In the Integron Methodology learning is seen as an ongoing process, ultimately under the control of the person (i.e. organism) that is (doing the) learning. To be truly effective, a unified learning methodology must focus on the process, and result in the learning process itself being strengthened. When this is done, content can be learned much more easily and is, in fact, a side effect of the main element of the process. In other words, teach people to fish and you build an industry. Give them a fish and you create beggars.

Section 2

THE TEACHING CONTEXT – AN OVERVIEW

The courses in designing Human-Computer interaction offered by the department of Computer Science at the City University of Hong Kong emphasise the importance of the user-centred approach to design. At the end of each course, the learners are expected to be able to use essential techniques of this approach with an adequate degree of appreciation for the issues involved and to demonstrate in the course outcomes their awareness of different factors that may cause communication breakdowns between people and application systems. In order to become so appreciative and aware, the learners have to learn the following:

- establishing the real user's need
- perceiving computers as tools that extend people and support users' tasks,
- universal human characteristics as the source of principles and standards in design,
- user-based conceptual models as frames for developing applications
- tests with real users, manual task analysis, fast prototyping, and sketching as tools for conceptual modelling,
- metaphors as mental tools best suited for guiding interaction between users and systems,
- interface as a transducer,
- visual rhetoric that deals with non-verbal communication,
- dialogues designed as user-oriented feedback loops, and
- scenarios of use.

Grasping these as concepts and making the concepts operational as skills is fundamental to design, especially the design of tools that *people* will use. It requires good understanding of people and their communication needs. It also requires a great deal of creative, divergent thinking. Learning to focus on the user in design has therefore been a major challenge to science oriented learners who for most part of their university time learn to attend to the internal operations and organisation of mechanical devices.

2.1 Previous approach to facilitating learning

To aid the learner in assimilating the theory and developing the practical design skills, in the past we always encouraged and facilitated learning by doing, case studies and an experiential, *hands on* approach.

Lectures were a mixture of a traditional, didactic, predominantly text-based and verbal instruction supplemented with a more constructivist, Socratic dialogue. They also incorporated short exercises designed to either prove that some human behaviour can be predicted or to show examples of a theory put into practice.

During course work the learners attempted to solve case-based design tasks of varied complexity (figure 1) and performed simple usability tests. The tasks and the cases were chosen by the facilitator. Tutorial tasks were normally distributed a week ahead of class. Tutorial time was spent on discussing offered solutions and the learners received feedback from the peer group acting as ‘human users’.

There was no thematic application relationship between the case studies in practical work and specific examples presented in lectures.

Design of an application

It has been suggested that many applications are built around a central screen which contains most of the objects that a person can manipulate. Thus a spreadsheet contains a grid from which we work, word processors a main document screen, etc. For the following application:

1. specify what you think the main objects would be to represent a problem.
2. what actions you would need to do on the objects
3. sketch out how you think the main screen would look.
4. describe how your screen would allow a meeting of several people to be scheduled.

An office organiser

The system is to help people control and organise meetings of personnel in an organisation. Each person has a diary of activities which is kept up to date and which tells what they are scheduled to do and where they will be for the next ten weeks. The office organiser is a system that finds possible times for meetings for a group of people and displays the possible times for a person to select the actual time. Note that people may have the time free but may be in a different city of physical location on the day in question and so would be unable to attend the meeting. Your system should also make provision for the situation when there is no time possible for all people to be at the meeting. The system will try to schedule meetings and ask all participants to confirm that the meeting time is all right before finalising the time.”

Figure 1. A typical case study

A typical mid-term quiz and the final exam consisted of four HCI case-related problems and the examined learners were expected to apply and demonstrate the designer skills they had practised during course work.

This type of learning normally required of each learner:

- a high command of the language of instruction
- a high degree of skilled real-time abstract thinking, and
- grounding of the semi-technical vocabulary in relevant real life experience²⁷.

Since in Hong Kong the language of instruction at the tertiary level is not native to the learners, the lecture material was available in handouts or on the course Web site. An extra bonus gained from the Web site, over and above its obvious merits for enhancing the command of the language, was threefold. The site was more interactive than the handouts. It contained links to other relevant HCI sites world-wide. It also provided a platform for sharing learner coursework to help them revise better and as a reward for good effort.

2.2 Difficulties associated with previous teaching methods

The approach to facilitating learning described above was used because it had been effective in *conveying* structured, factual knowledge of the subject to large cohorts of learners and for *actively engaging* them in small tasks of design. Although we provided the learners with a fair amount of experience, the type of experience we provided was not entirely effective in actuating their natural learning potentials. The reasons were the following.

- Focus on subject-based learning (desired outcomes)

We selected lecture and classroom activities from the standpoint of how to best *help the learner acquire subject-based, practical HCI skills*. We did not select them from the standpoint of how the Hong Kong learners actually *learnt*. Nor indeed did we consider any factors that prevented them from learning effectively and less still the factors that could accelerate their learning.

²⁷ Symbol grounding problem. Harnad, 1990. For example, one can argue that people can only fully understand what a 'tool' means when they don't have one at times when that tool is needed.

- Inadequate symbol grounding experience

Even after multiple discussions, and the use of various practical exercises, it was noticeably difficult for the learners to grasp and meaningfully use the fundamental design concepts such as *the user's need*, *a design metaphor*, *conceptual* and *mental models*, or even *computers as user centred tools*.

Although such abstract concepts could be verbalised and defined, and examples of them could easily be provided to the learners, for the learners those abstract concepts, as well as the symbols associated with them, remained to a large extent ungrounded in real life experience.

Consequently, learners tended to perform corresponding design tasks without being fully aware of the full implications of what it was they were actually doing and why they were doing it. The experiential, every-day knowledge of individual learners had provided some grounding. As that knowledge was *not shared* by a cohort as a whole, explanations we offered met the learning needs only of some but not all the learners.

- Inadequate support for a transition process between their old learning habits and the preferred new learning habits.

One source of difficulty for the HCI learners was the open-ended nature of design tasks that do not converge on a single model answer. Performing those tasks involves numerous iterations with little trade-off in certainty that a proposed solution is the desired and the only one. Learning how to design interfaces that help people use computer tools, therefore, does not fit in with the preferred learning model of the learners based on memorisation of lecture notes and working towards satisfying model answers (see further Pp. 98-99).

Another source of difficulty was the disjoint nature of case studies that did not provide a spiral organisation for knowledge uptake and did not fully support a problem based approach to learning.

- Inadequate sensory enrichment of the physical learning environment

In presenting and discussing course material preference was usually given to text based, hence not rich enough, auditory and visual inputs and outputs. Learning usually took place in traditional lecture theatres, classrooms, or teaching studios designed for work at

computer terminals only. Such environments afforded relatively few mental, social and physical activities. This constraint was especially acute in the teaching studio where learners always had to sit with their back to some other learners or the learning facilitator.

- Inadequate learner interaction and socialisation

Learners usually learnt in groups of their own choice and avoided contact with “strangers”, i.e. other classmates outside their small social group. They also avoided face to face contact with the facilitators, even if encouraged to do otherwise. More proactive learners tended to dominate staff-learner contact time, partly due to time constraints and also the learners’ lack of appreciation of the importance of social interaction to self reflection, own self development and own learning process.

In consequence, in the past we required learners to adopt different *mindsets* for processing information, different attitudes and different learning strategies but we provided no *environment* where such a transition could happen as a matter-of-course.

2.3 Towards in-depth HCI knowledge and a new method of instruction

Our decision to actuate natural learning potential in learners in this project brought to the foreground some previously unattended pedagogical issues. Apart from the fact that we had to understand and address the process by which people naturally learn, we had to uncover and transform learners’ inhibiting attitudes and ineffective habitual learning strategies. In facilitating learning we had to understand fully our own shortcomings and those of the learning environment. We also needed to work out new assessment criteria for monitoring and rewarding genuine achievements in the learner transformation process.

These considerations, of affording better learning, have called for wide ranging modifications to the way of delivering material and assessing the core HCI course outcomes. The modification, discussed in detail in the following sections include but are not limited to:

- Focus on learner transformation
- Symbol grounding experiences
- The pre-test and post-test for testing percentage of skill improvement (that replaced a mid term quiz)

- Iconic lecture slides to facilitate anchored uptake by Long Term Memory
- Access to lecture slides on the Web for revision only
- No handouts of the lecture material
- Accelerated learning techniques in delivering lectures
- Accelerated learning tutorial activities
- More flexible physical learning environment
- Co-ordinated case studies for lecture and coursework
- Assessment strategies that rewarded whole person development

Table 1 shows a distribution of these modifications in the three HCI courses relevant to the current project.

The cohort of learners which we exposed to the Integron Methodology were the second year undergraduates of Computer Science Department in the academic year 98/99.

In analysing the project outcomes we made comparisons with two other cohorts of learners, namely, the second year Computer Science (CS) undergraduates in the preceding academic year 97/98 and the third year undergraduates of the Chinese, Translation, and Linguistics (CTL) in the concurrent academic year 98/99 (the “Linguists”).

We chose the second year undergraduates of Computer Science Department in the 98/99 academic year to be exposed to the Integron Methodology both because of the difficulty we had in teaching key elements of the course in previous years, and because of the importance of this course, as a core module, for turning out graduates who can design interfaces that people can use.

CS 98/99 cohort 114 2 nd year undergraduates	CS 97/98 cohort 98 2 nd year undergraduates	CTL 98/99 cohort 37 3 rd year undergraduates
New Credit Unit System	Old Grading System	Old grading system
2 Credit units 2 Semester hours (equivalent)	2 Credit units (equivalent) 3 Semester hours	2 Credit Units (equivalent) 2 Semester hours
Core CS course	<i>Core CS course</i>	Servicing CS course
Focus on learner transformation	Focus on subject-based learning	Focus on subject-based learning
Symbol grounding experiences	NIL	NIL
No handouts of lecture presentations	No handouts of lecture presentations	Handouts of lecture presentations
Web access to PowerPoint lecture slides for revision only	Web access to lecture presentations at all times	No Web access to PowerPoint lecture slides Access to text based web lecture presentations at all times
Accelerated learning method of lecture delivery	Traditional method of lecture delivery	Traditional method of lecture delivery
Accelerated Learning tutorial activities	Traditional classroom tutorial activities biased towards learner presentations	Traditional classroom tutorial activities biased towards practical use of software
Pre-test & post-test	Mid-term quiz	Pre-test & post-test
1 design assignment & 1 diary assignment	1 design assignment & 1 usability assignment	1 design assignment
Shared exam with CTL cohort	Partially share exam with both CS and CTL cohort	Shared exam with CS Cohort
Free style tutorial classroom	Traditional tutorial classroom	Computer studio lab for lecture and tutorial 2 hour block
Traditional lecture theatre with multimedia facilities	Traditional lecture theatre with multimedia facilities	

Table 1. Summary of course content of the three HCI courses

As the Design of Human Computer Interfaces for Communication course is not a core requirement for third year undergraduates of the Chinese, Translation, and Linguistics (CTL) course, for this cohort we decided to make only those modifications to what has been done in previous years which were possible in the teaching studio environment. Since the modifications could only be small, this allowed us to compare their learning outcomes with the cohort exposed to the Integron Methodology.

Section 3

PRINCIPLES OF THE INTEGRON METHODOLOGY

In the introduction we have given a general outline of how the Integron Methodology differs from, integrates, and builds upon a range of different pedagogical methodologies. While a general overview is good, the question still remains: what exactly is an Integron, and how does it operate?

In essence, application of the Integron Methodology involves the design, development and delivery of specific Integrans (holographic, integrated, experiential learning units) for the purpose of developing a learner. An INTEGRON is a set of structured real life experiences that trigger and facilitate the (re-)integration processes in learners that lead to desired outcomes.

Integrans transfer knowledge, draw out understanding, and generate meta-cognitive transformations. The nature of the Integrans developed for any subject or group of learners are specific to the context, the subject matter, the desired outcomes, and the starting point of the learners. Hence, when viewed superficially, each course developed using this Methodology may seem very different to other courses similarly developed.

However, despite these seeming differences, the methodology is held together by two powerful strands. The first strand is a set of principles and unique features that are used to guide development of both an Integron based course as a whole, and each individual Integron within a course.

The second strand is the high level “theme” of the methodology. This is, simply, to support the development of more fully integrated and balanced human beings.

In this section we summarise the distinguishing features of the Integron Methodology. Along with a textual description, each major feature of an Integron is summarised visually, with respect to its methodological content in the form of a mind map²⁸.

²⁸ Mind Mapping is a specific method for organising information visually and spatially. Originally developed by Tony Buzan (Buzan and Buzan, 1993), it uses as its basic metaphor the organising principles of the brain i.e. linking, networking and spreading from a central “node”. We have found this tool useful both for helping to develop Integrans, and also as a metaphor and tool used in the teaching process itself.

3.1 Strategic learner transformations

In our view, natural learning is not simply a matter of remembering and regurgitating facts. Rather, natural learning involves a transformation in the internal life and internal organisation of the learner.²⁹ By its very nature, the Integron Methodology is a strategic discipline. By this we mean that it requires open and conscious consideration (on the part of the learning facilitator) of specific transformations that learners need to go through in order to be more accomplished at the end of a course of learning than they are at the beginning. When using this Methodology one pays specific and detailed attention to the process of **learner transformation** ahead of the content that is to be taught.

In the first stage of developing an Integron based course, the learning facilitator must set up a general, top-level course goal for learner transformation. The creation of this goal is of fundamental importance in the design of the course as it shows the gap between present and desired states, and therefore suggests strategies for closing the gap. It also requires working out the way the world will be when the transformation goal has been achieved (satisfaction conditions).

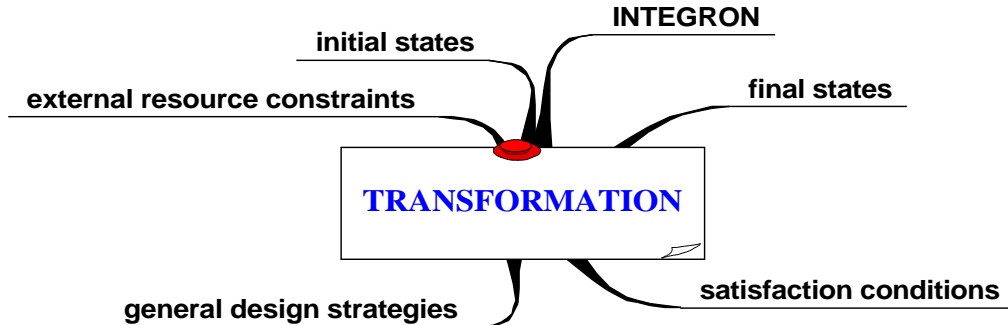


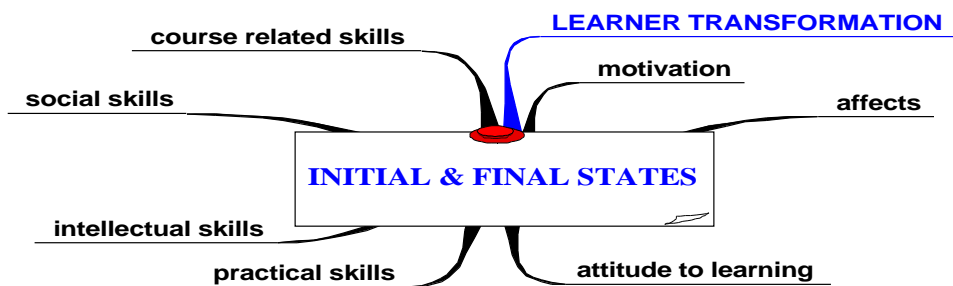
Figure 2. A goal template for learner transformation

²⁹ This transformation could well be in the form of opening up new neurological pathways. It is, however, not the purpose of this report to delve too deeply into theoretical issues.

This, in effect, defines the problem space for designing any course. The process of deciding how to move learners from the initial state to the desired state is, therefore, strategic in nature.

From the viewpoint of the Integron Methodology, the initial and the final learner states specified in the transformation goals relate to the **holistic** development of learners. Such states include four fundamental types of competence: social, emotive, intellectual and practical/physical, and necessarily include learner motivation states. The targeted competence transformation states can be either general or more specifically course related depending on the starting point of the learners.

The greatest challenge, of course, is that the desired end state requires internal restructuring on the part of the learner. In other words, especially if natural learning and integration is to occur, the learner's end state is structured very differently to the learner's starting state. The end state is an integrated whole, with its own internal logic, connections and structure. The change from one learner state to another appears to be quantum in nature, in the sense of an electron being able to take one orbit around a



nucleus, or a different, higher orbit, but not somewhere in between. In our view, a quantum change in a learner's state implies that the knowledge, facts, beliefs, affects, etc. of the learner can be integrated and organised in one way or another, but not both ways simultaneously.

Figure 3. Initial and final learner states

Relevant course design questions here are: Under which conditions can such restructuring and integration occur? What are the internal and external forces governing this process? What kind of environment can act as a trigger? How do people assimilate to that environment? Is the assimilation necessarily slow or can it be facilitated and sped up? Is

it conscious or unconscious? In short, ‘What is the pragmatics of integration?’(as opposed to the widely studied pragmatics of interaction)³⁰.

It is important to realise that any learning interaction is, by nature, time bounded. A learning facilitator is limited by the realities of life on the physical plane and must sequence communication in a fashion significantly more linear than the desired learner end state. So, the question becomes, how do you take a multidimensional world view, along with the relevant affects, facts, knowledge, beliefs, skills, etc. and make this available to learners in a way that they can begin to reconstruct the same, or similar multidimensional world view?

Clearly, traditional didactic forms of teaching are probably the least suitable for achieving such an outcome. Our solution to this particular problem was the development of the INTEGRON.

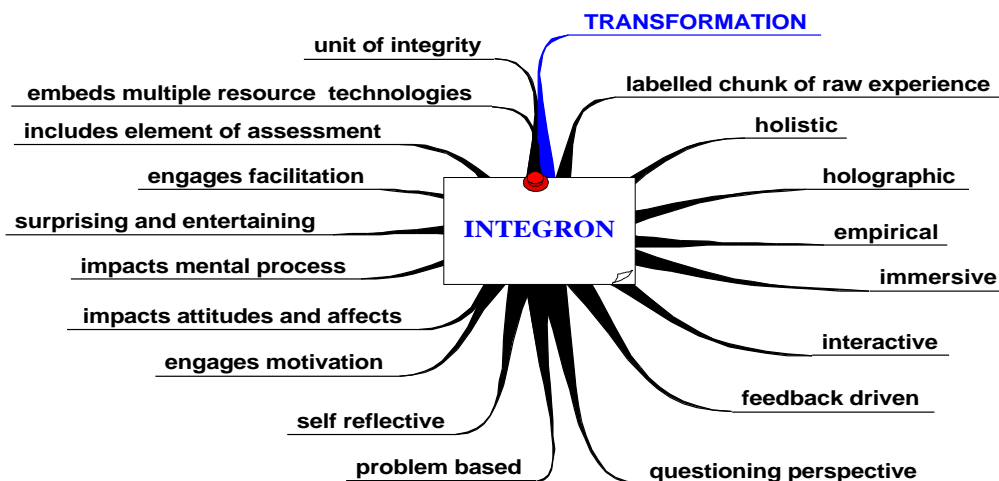


Figure 4. Key features of an Integron

³⁰ Gorayska and Lonsdale (1999).

3.2 Design principles

The principles that guided our development of the methodology included the following.

3.2.1 Important learning happens at an unconscious level

Much of the research into Life Long Learning (see page 12), and similar paradigms, has focused on the promotion of deliberate learning habits within learners, with the conscious rejection of learning that happens naturally and easily within a real life context. As has been noted elsewhere³¹, however, it appears that much of the learning that is significant for people occurs at an unconscious level, with only a modicum of conscious mediation.

Consequently, one of the design principles for the Integron Methodology is that the learning facilitator must pay as much attention to unconscious learning as to conscious learning. This principle generates a number of corollaries:

Communicate Through Doing

Children learn as much by watching and modelling what adults do as by listening to what adults tell them. The same appears to be true for adults who are learning. While adults can benefit from a logical discussion of what is required of them, they often benefit even more from being able to observe how others generate desired outputs. And, this learning is likely to take place at an unconscious level as much as it does at a conscious level. Consequently, a learning facilitator can transmit critical knowledge or skills to learners simply by demonstrating what can be done.

For instance, in the HCI course, we used a series of high impact iconic PowerPoint slides on a number of occasions. As a consequence of this, during their final presentation, a significant proportion of learner groups made use of similar iconic presentations. It is important to note that this was *never* taught explicitly as part of the course, but only implicitly, in a number of different ways.

Also, some learners in the group discovered that they could learn as much from observing what we did as by listening to what we were saying.

³¹ Lozanov (1978); Schuster and Gritton (1985); Rose (1985); Rose and Nicholl (1997)

“Today, the lecture lesson is with so many people. I think it is because the lecturer has send the e-mail to all students and said that she will give some “impact” to all.

Actually, it is surely the impact. The lecturer make the computer as the robot and communicates with the robot. I think it is the classic of the human computer communication and often occurs in the file in the past. So, in the lesson, I am not placing attention onto the content of presentation, but on the method.” Wong Man Kwong, Benny

Don't talk about some of the key learning points

Related to the above point, it is often unnecessary to verbally communicate key points. Rather, demonstrating what is possible, or creating a particular experience, is enough for learners to take on board a key concept or make a new connection.

Be open and flexible to feedback

Effective learning requires a learner to be open to feedback, and to be able to respond to feedback by changing internal mental and emotional structures. Sadly, many learners do not have this meta-skill. However, it can be learned, and is best done so at an unconscious level. Consequently, a learning facilitator needs to respond evenly and openly to all feedback from learners in a learning environment. The quality of the learning facilitator's response to feedback, of all kinds, communicates a meta-message about how learners can also deal with feedback in a constructive way.

3. 2. 2 Everything is a resource

Another key design principle is that everything that happens during a learning interaction or learning process can be used to help move learners to the desired end state. As long as the facilitator has a full understanding of the desired end state, s/he can respond flexibly to anything that might transpire during the learning process. Two corollaries of this principle are:

Use the learning group as a resource

Within the Integron methodology we see the group of learners as being an important resource. The knowledge and experience within each learner can be tapped in a way that makes it available for others in the group. And, the patterns of interaction between individuals in the learning group can also be used to generate learning outcomes.

Whatever happens is in your favour

Another important idea is that whatever happens in the course of a learning interaction can be used to further the learning goals for the group. As an example, in one small group interaction within the HCI course, a young man in the group got somewhat agitated and communicated with one of the facilitators in a gruff and unpleasant manner. His intention, however, was to take charge of a part of the proceedings in the group interaction.

At the time we had a choice of response. We could have chastised him for the way in which he communicated, or we could see what was happening as a positive step and respond accordingly. Since one of our meta-goals was for learners to take personal responsibility both for their own learning and for the integrity of their group, we ignored the tone of the learner's communication and instead responded to the learner's wishes vis-à-vis the process that was unfolding.

On another occasion, a failure of computer equipment in the middle of a large group interaction (lecture) allowed us to point out the ubiquity and importance of interfaces, and the difficulties that occur when they fail.

3. 2. 3 Natural learning tends to be holistic and integrated

Another major principle is that, as discussed earlier, natural learning tends to be holistic and integrated. It is made up of rich complexes of sensory and linguistic information units, structured in an integrated way within an individual. Using a purely analytical and linear approach therefore makes learning more difficult. Traditional approaches to learning, as discussed earlier, deprive a learner of sensory input, and often delete the connections that would allow a learner to perceive new viewpoints in a holistic, integrated way. As a consequence, the design corollaries are:

Multiple level communication

As much as possible, communication in the learning context should take place on multiple levels. This means that both what is communicated, and how it is communicated, need to be designed into every learning interaction. In essence, rather

than being posted out point by point, messages can be layered and embedded within the learning interaction in a number of ways.

Full sensory communication

We assume that holistic learning is grounded upon multi-sensory representations active within a learner's nervous system. For instance, it has been said that Albert Einstein was able to be so creative indicates that he perceived his mathematical problems in terms of three dimensional, kinesthetically sensed spaces. As a consequence of this viewpoint, a learning design principle is that the more rich the material to be learned in terms of its sensory characteristics, the easier assimilation by the learner will be.

3. 2. 4 The Process generates the learning, not the points

Our impression of traditional teaching approaches is that the teacher spends significant amounts of time developing an understanding of a subject, then presents this understanding. All learners have to do is remember what has been taught. This, we believe, is counter productive. Assuming that deep learning is the result of new connections and restructuring of the learner's internal world, giving the "result" to a learner in fact stops the learning process.

Therefore, content and conclusions need to give way to process. The role of the learning facilitator is to design a learning process that allows learners to make their own connections, and build their own structure.

Motivation is the Key

No matter how well organised a course may be, if learners are not motivated they will learn less, and more slowly, than if they are motivated. Consequently, generation of motivation is a critical part of any learning process. Learning facilitators are in control of a number of elements of the learning process that can lead to greater learner motivation.

No spoon feeding

From the point of view of a learner, if you know someone is going to give you the answer, why bother working it out for yourself? So, in our view, the first thing that a learning facilitator can do to build motivation is cease spoon feeding learners with packaged “answers”.

Use surprise and difference

Most individuals are primed to notice difference in their environment, a propensity that has obvious survival value for an organism. Consequently, in designing a learning interaction it is important to create enough difference and surprise to capture the attention of the learners. In the HCI course we achieved this aim by showing learners things that they should know about their own discipline but likely did not, by leading them from familiar to unfamiliar areas, and by continually making changes to the learning environment so that learners never quite knew what was to come next.

Economy of mental effort (you get what you pay for)

The third element of importance in motivation, especially as it relates to adult learners, is that you get what you pay for. Adults tend to focus on what is important to their survival, and in most cases are less likely to want to learn things that have little or no immediate relevance. Consequently, in designing learning interactions, it is important that the pay-offs are seen as important and relevant to the learners. In the case of the HCI course we made use of the assessment criteria to generate motivation within the learners on the HCI course.

3.3 Features of an Integron

The Integron Methodology is essentially our way of integrating the design principles outlined in the previous section.

3.3.1 Unit of integrity

One of the critical insights of the Integron Methodology in a teaching context is that an Integron is what it teaches. In our particular case, the course on designing interfaces was itself presented as an interface: learners were taught to perceive an interaction between themselves and the learning facilitator as an instance of an interface and they learnt to see lecture presentations as samples of different interfaces.

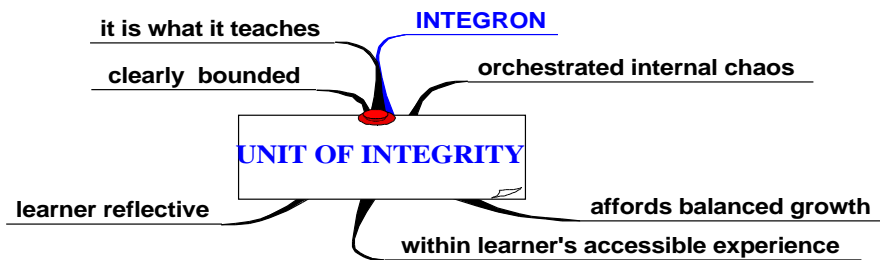


Figure 5. Integron as a unit of integrity

We created Integrons as tools for developing mental tools (an element of interface design). Metaphor was presented in the context of an Integron which itself is an instance of metaphor, and so on.

As a unit, an Integron has to have its own clearly delineated boundaries. For example, a situation can be created or simulated within a classroom, where the classroom session binds the situation. Within its own boundaries, the Integron makes possible a balanced growth. The growth occurs because internally an Integron is only loosely structured. Within this loose structure, an Integron has randomly distributed reference points to facilitate triangulation. By triangulation we refer here to the navigation metaphor that allows one to know one's position in a two dimensional space by looking at the relationship between three points.

In the learning context, these reference points must include the learner's accessible real life experience. From the perspective of the course as a whole (where the course serves as a boundary), one such set of reference points is the triplet of 1) available, didactic, logically structured, linear, left brain, material in reference books where theory about the taught subject can be found, 2) a set of specific examples for the theory provided to the learners during lectures or in the books, and 3) a set of concrete experiences the learners are taken through that provide raw, right brain, sensory data for grounding the two.

3.3.2 Labelled chunk of raw experience

An Integron is also a labelled chunk of raw experience which the learner becomes immersed in. As mentioned in the previous section, it provides the learner with sensory data for him or her to develop knowledge structures on their own. An Integron is therefore non-linear and avoids the pitfalls of logical organization of the material presented for learning. A natural tendency of the human brain is to impose and create structure. This cannot easily happen if the learning material is already well

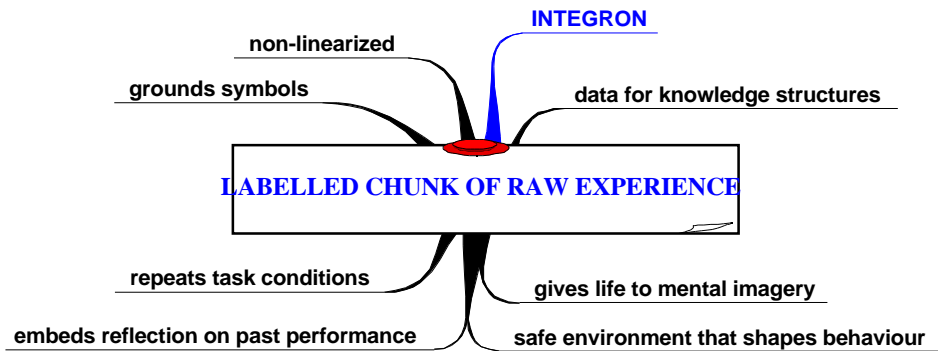


Figure 6. An Integron as a labelled chunk of raw experience

digested and categorized by the teaching learning facilitator. The well organized notes distributed to learners which summarize what has to be learnt inhibit this natural process and, instead, afford the model of learning that is biased towards mere memorization without reflection.

By contrast, an Integron continually encourages learners to reflect on past experience. This embedded reflection is triggered by repeating tasks conditions (either the task itself or the environment in which the task is initially carried out) at different points in time throughout the course.

For example, early on in the HCI course the learners were asked to build a lego model of the problems other learners at the City University of Hong Kong faced that prevent them from learning effectively. This model building experience was originally discussed as an example of the design process known as visualization. Later on, this same experience was recalled to serve as an example of a throw away metaphor for the design process.

Hence, an Integron gives all learners a common set of raw data that can be interpreted in a variety of ways at different times. This shared, raw experience grounds the vocabulary used in a course: it becomes an anchor for negotiating meanings and deriving further understanding in the group as a whole. An Integron makes it safe for the learners to explore experiences in this way. It acts as a safe environment that shapes behavior.

3.3.3 Holistic environment

As Integron targets the development of the learner as the whole person. This means that some elements internal to it are interacting with the learner's self image, self worth, and self confidence. Balancing of the learner's self actualization and democratization are written into the fabric of the course. The learners learn to belong to a group and at the same time each single learner is respected as an individual member of that group.

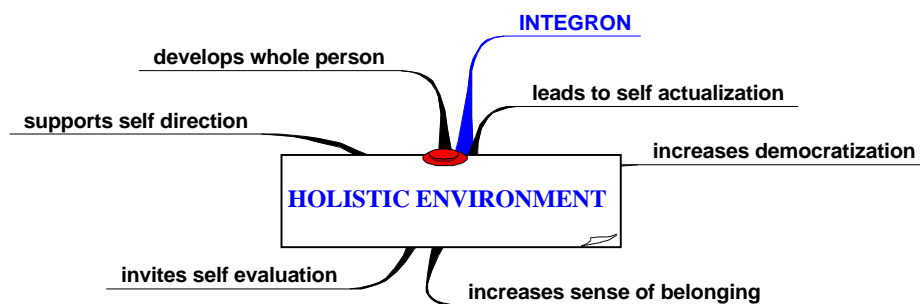


Figure 7. An Integron as a holon

In our course the learners worked in different small groups for each task. As they never select their partners themselves, in fourteen weeks each learner had to interact as a member of a group with all other learners in the course. This avoided formation of cliques and breaks the barrier which naturally comes from fear of working with strangers.

At the same time, during debriefings, each learner was invited to share their own personal observations and own personal impression of an activity or an exercise. Since personal experience is always of value and cannot be wrong, the learners got plenty of support for

their own views and were helped to develop their own self direction. This in turn helped them develop their own identity and respect the different identity of others.

3.3.4 Holographic environment

If it is to facilitate natural learning, an Integron must be holographic. If one thinks about what one knows, say, about a certain concept it is self evident that this knowledge is constructed from: multiple experiences; images, sounds and feelings; remembered advice; sudden insights; etc. To be truly effective a learning Integron must reproduce as faithfully as possible the holographic nature of something that is naturally learned. Therefore, to be of use it has to be directly experienced. It requires total immersion of the learner within a real life situation which should have as many facets to it as possible. Once immersed in such an environment the learner has available many angles and hooks with which to understand while at the same time having a full representation of the knowledge to be gained, even if this is not yet conscious.

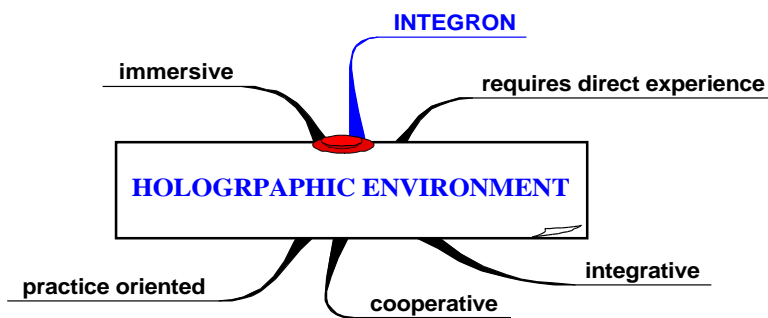


Figure 8. An Integron as a holograph

3.3.5 Empirical environment

Within the Integron methodology learners learn to take all perceivable experience as a source of knowledge and to adopt the view that those who make no mistakes will perhaps never make a discovery.

In our course, if things failed to work, the learners were asked to reflect on why it had happened and how it could be put right. They had to think of, and analyze, the consequences in terms of disadvantages and advantages of failure.

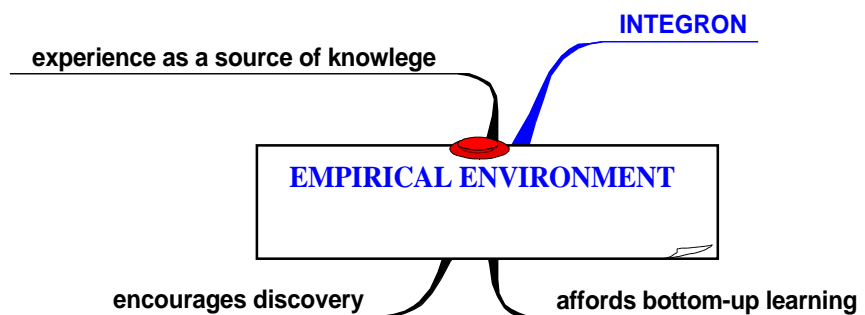


Figure 9. An Integron as an empirical environment

In an Integron, current experience is linked to new observations. Since brain cells are known to grow in enriched environments, in an Integron the learners' environment is continually enriched.

One good example of such progressive enrichment are posters on the classroom walls displayed each week. In the HCI course, whenever new material had been introduced in lectures, the content of the PowerPoint slides was subsequently slightly modified (new things added, different clipart used for the same message, etc) and the new posters were hung for all to see. These posters were not discussed in class. Instead, they were intended to attract peripheral vision and be processed unconsciously.

This type of approach to real life experience provides a context that affords faster learning. Learners are left with more questions than answers, and more data than explanations. They receive psychological priming in the form of raw experience with some reference points for them to mentally fill in "the gaps". In providing an environment that leads to questions, the learning facilitator creates "nodes" in the learners' brains and allows the roots of those nodes to grow (also see section 3.3.9 below).

3.3.6 Immersive environment

An Integron totally immerses the learner within an experience. To be most effective, the experience ought to be predominantly sensory (include all the senses). Verbal explanation of the phenomenon the learner is experiencing is cut down to the minimum.

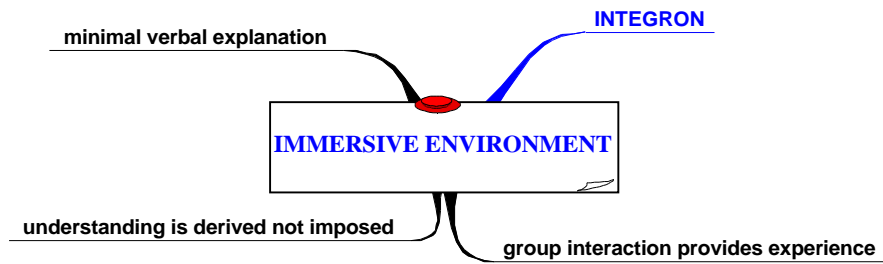


Figure 10. An Integron as an immersive environment

Human neurology needs to derive meaning. As deep understanding is derived and not imposed, Integron group activities are often organized around clearly communicated outputs. Little, or nothing, is communicated on how to achieve these outputs. Solutions can arise from group interactions that create the shared experience (in the form of raw sensory data) that can then be reflected upon.

For example, we gave our learners a series of tasks which required the use of tools and we gave them no tools to perform those tasks. The learners worked in small groups, one group per one impossible task. Each group was given the expected final output and no other instructions. As soon as the learners found themselves in that situation, within each group they spontaneously began to negotiate and interact. Searching for a solution, they have been creating their own shared experience.

3.3.7 Interactive environment

Within its own well defined boundaries an Integron allows the learners to interact with the learning facilitator. Often the learning facilitator opens a loop for a theme with a description of some activity, or a story, or a movie clip. The learners fill in the loop with

their own activities and the learning facilitator closes the loop with further questions that lead to other related themes.

For example, early on in the HCI course, at lecture time we showed our learners a video clip from the movie “2001 - A Space Odyssey”. In this clip a monkey suddenly conceives of a bone as a tool for smashing things. We then asked the learners to prepare for the following tutorial their own skits about human evolution. As anticipated, all skits involved the evolution of tools of some sort, which allowed for an introduction of the concept of the relationship between humans and tools. After the learners had performed the skits, we asked them to reflect in their own time on the question: ‘What is design?’

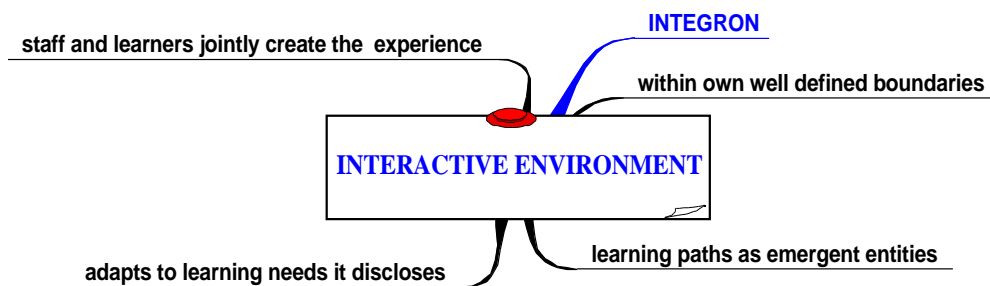


Figure 11. An Integron as an interactive environment

It is in such interactions that flexibility is crucial in adapting to the learner needs that become exposed by those interactions. Since an Integron is a loosely structured unit of experience, there will be many different learning paths the learners may take within it. The paths the learners need to take, which are dictated by the individual belief models they bring into the situation, are usually communicated by the way they respond to the triggers set up by the learning facilitator.

3.3.8 Feedback driven environment

An important part of the Integron methodology is the use of multiple feedback loops. The sources of feedback are many. During an Integron based course the learning facilitator is receiving feedback from learner responses, and responding to this with appropriate modifications in the course.

The learners, too, are embedded in the feedback process. Bearing in mind various environmental constraints, feedback is delivered as close in time to a student action as possible. So, in our course, an exam was given in the first large group interaction (lecture). Immediate feedback on exam performance was then given in the first small group interaction (tutorial). This internal pre-test, as well as subsequent post-test exams, midterm evaluations of interim outputs, and feedback questionnaires, allowed our learners to continually test themselves.

These tests also served as a measurement of the percentage of improvement for the purpose of the overall assessment of the learner coursework (see further section 3.3.17).

Apart from debriefings and tests, our learners received positive reinforcement whenever they internalized and spontaneously used the technical vocabulary of the HCI as metaphors for some of their own classroom activities.

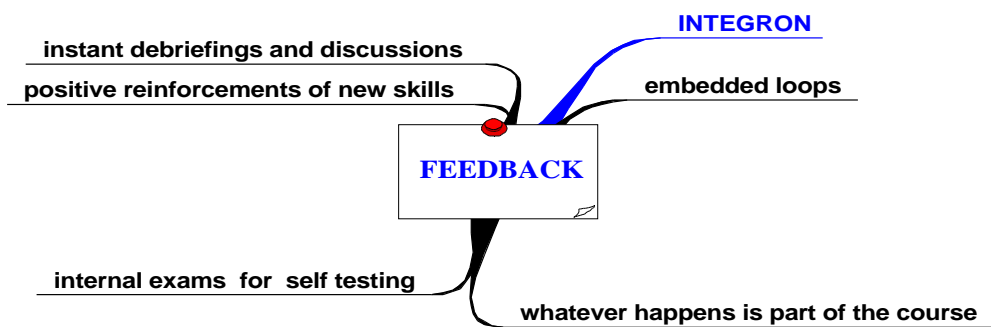


Figure 12. An Integron as a set of feedback loops.

Another example of how feedback can be employed is the use of “observers” during classroom exercises. In many of the exercises that we set up in our course some students were given a task to do, and others were requested to observe the process of the task being carried out. Subsequent debriefing on what actually happened provided feedback to students who had been carrying out the task. Then, the learning facilitators would give additional feedback, which also served as feedback to the observers on how well they had observed what had transpired in the exercise.

Also, feedback is “looped” wherever possible. By looping, we refer to the process whereby common, grounded experience of the learners (i.e. significant events that have happened in the course) is referred to on many subsequent occasions, each time with a new slant being given. So, for instance, learner experience with the exercise on tools was referred to many times, each time as feedback related to some development in the learning process.

As part of this process, the most innovative form of feedback that we used was to show the learners edited video clips of their classroom activities in order for us to bring to their consciousness things they may not have noticed or may not have been aware of at the time when they were experiencing a given situation. In this way, whatever happened in the course was used as part of the course material. For example, we combined the monkey clip from “2001 – A Space Odyssey” with clips of the learner performance in the session of “life with no tools” to trigger further reflections on the process of design and the role and evolution of tools.

3.3.9 Questioning perspective

One of the challenges of life-long learning is developing individuals who are curious and have a well developed questioning perspective. It appears to us that many individuals become very fixed in their world view at a young age, and accept too many things as is. Therefore, in the Integron Methodology it is important to break people out of their fixed mindset, and help them to develop a very strong questioning perspective.

An essential characteristic of Integrons, therefore, is that they distort familiarity. Such distortions, if kept within the learners’ own comfort zone, naturally afford the questioning perspective. On the one hand, those distortions compel the learner to continuously formulate new questions. On the other hand, they lead to continuous shifts in perspective from which the learner is asked to view things.

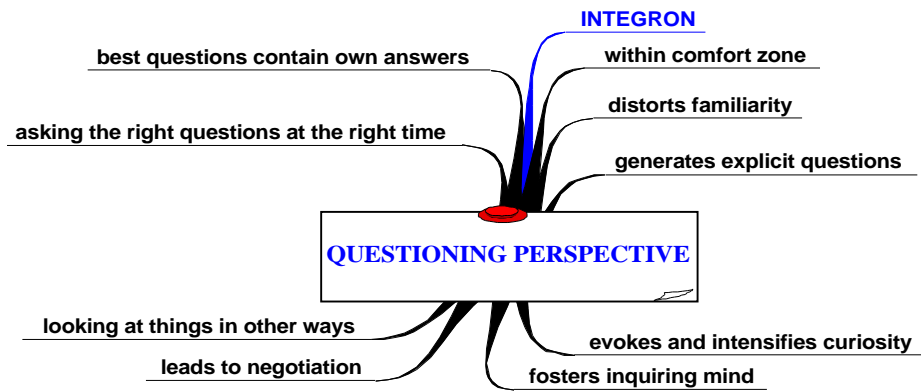


Figure 13. An Integron as a questioning perspective

If we want the learners to be life long learners we have to teach them not only how to ask questions but also, and more importantly, how to ask the right questions at the right time. A well formulated question converges the thought processes on its own answer. Therefore, the more the learners are able to ask the right questions at the right time, the easier it becomes for them to find better solutions to the problems at hand.

The shifts in perspective, or looking at things in novel ways, naturally lead to subtle shifts in familiarity which naturally triggers curiosity. The curiosity, in turn, acts as a natural trigger for questions. The questions, in their turn, help learners develop an inquiring mind. In fact, the whole course, designed as an Integron, is oriented towards formulating questions. An unanswered question keeps the mind in the state of searching, even if this state is dormant for some time, and makes possible Newtonian, eureka-like, creative leaps³². It also increases the need for communication and negotiation between the learners and between the learners and the learning facilitator.

This habit of questioning is further reinforced by the learning facilitator posing questions to learners ‘*post factum*’. That is to say, the learners are often immersed in some experience first and only at the end of this experience they are asked pertinent questions that relate to it. The realization that there are many different ways of thinking about each experience builds a mindset in the learner that is constantly searching for multiple meanings.

³² One of the questions we asked ourselves in designing this course was “what preconditions were present for the individuals who first conceived of some of the key concepts we were teaching? And, how could we recreate similar conditions so that our learners would have the opportunity to make similar types of creative leap?”

3. 3. 10 Self-reflective environment

All aspects in the Integron design provide a mirror upon themselves. For example, not only the learners but also the learning facilitator develop as whole persons. In fact, all the participants become transformed. That transformation reflects back on the Integron itself. While the Integron Methodology develops learners and the learning facilitator, this same process leads to modifications and adjustments to the course Integron such that it better fits particular learner paths. In short, within an Integron everything intra-communicates and inter-communicates.

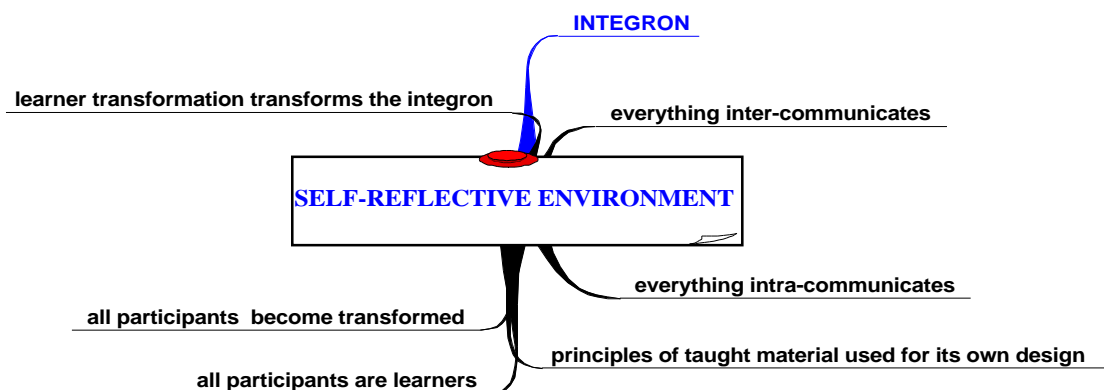


Figure 14. An Integron as a self reflective environment

In a larger teaching context, it is therefore important and effective to use the principles operating in a particular taught domain to the design of relevant training Integrons. For instance, physics can be taught not only in relation to the specific environment in which the teaching takes place but also in relation to the physiology of the human body. In this way the learner can always self-reflect within his or her own accessible experience.

3. 3. 11 Accelerated Problem based learning environment

Within Integrons situations are created which provide obstacles for the learners in performing course related tasks. In order to progress, the learners must recognize those obstacles for what they are, i.e. as new problems to solve, and subsequently find out effective ways to actually solve them. These situations comprise carefully structured sets

of constraints for the learners to first ‘get stuck’ and thus become ready for creative leaps. In dealing with such problems the learners must be creative and collaborative. They develop a stronger personal bond and team spirit. They have to draw knowledge from their memories and apply it to new situations. This increases their understanding of the problem.

To accelerate this type of understanding we believed that our learners would handle problems more effectively if they had new mental tools, or strategies, for recognizing, analyzing, and solving new problems. Consequently, as part of the course Integron we built in coaching for the learners to help them develop mental tools that they could then use in their own problem solving.

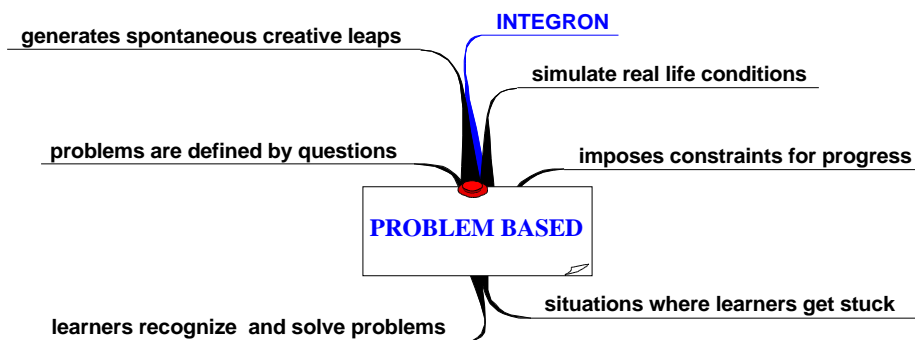


Figure 15. An Integron as a problem-based environment

This resembles laboratory simulations of real life events with a minimum of external input and a maximum possibility for internal interactions. Such simulations are confined environments where certain conditions always remain constant (they are isomorphic to their real life equivalents) but other conditions can be experimented with to achieve or test for pre-planned behavioral effects.

One example of this kind of simulation is the Hal lecture we delivered towards the end of the course. In this lecture we presented material related to visual rhetoric: use of color, economizing on space, silent meanings of the organization of interface objects, etc. This material is readily available in textbooks. The learners may also be familiar with it from their past experience of programming or using computer applications. For this reason we

had embedded this information in a novel presentation style. We simulated a talking computer, facial expressions and all, on the projection screen and we communicated with it in natural language. We issued commands to Hal (the name we gave to our simulated intelligent computer³³) for it to show variants of one and the same interface by changing colors, positioning and organizing selection buttons or diagrams differently, etc.

Before the lecture, we had informed the learners that there would be a surprise for them that week but we did not tell them what kind of a surprise it would be exactly. Neither did we explain to them what the surprise was after the lecture. We kept them guessing what the lecture was about, which they had to work out for themselves. Some learners subsequently reported in their diaries that, as soon as they had recognized that the content of the lecture was not new, they concentrated on the method we used to present, and its relevance to the design of interfaces.

3.3.12 Surprise and entertainment

The element of surprise and entertainment in an Integron is essential for at least two reasons: (1) In every day life the current generation of learners is exposed to an environment that is predominantly visual, colorful, fast, overloaded with information and which is interpreted in a distributed fashion. For example, numerous TV channels are surfed and several programs are watched simultaneously; (2) The Internet, which is notorious for its continuous ‘distracting from purpose’, is also surfed. In this context, entertaining and surprising learning environments provide a good cognitive fit and help extend the learner’s attention span.

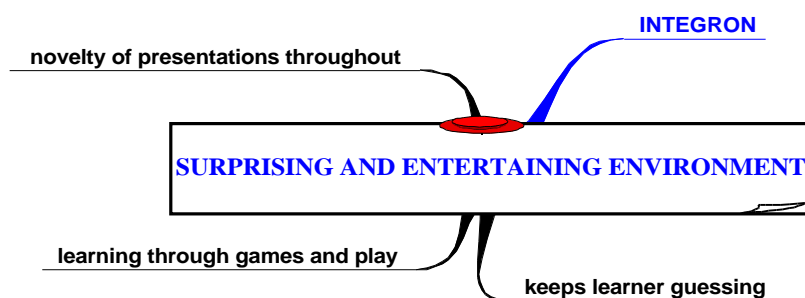


Figure 16. An Integron as a surprising and entertaining environment

³³ Hal was the name of the computer that starred in the movie “2001 – A Space Odyssey”

Of equal importance is the fact that too much conscious attention and a mindset of “cramming” blocks memory and induces forgetfulness.³⁴ Hence, the element of surprise and entertainment in an Integron also serves to *distract attention from conscious learning*. The distraction of conscious attention is a core element of accelerated learning, and is believed to result in a reduction in the effort needed to command new material to long term memory.³⁵

One way of achieving this is to let learners learn important material at contact time through games and play.

For example, on one occasion on our course we gave the learners an editorial task to perform in small tutorial groups. In a very short time they had to reduce a hard copy of an article on *designing with metaphors* to one sheet of A3 camera ready copy, using traditional methods of scissors, glue, rulers, etc. The conscious attention of the learners was directed to the analysis of how best to computerize a manual editor’s task. But they also learnt, indirectly, about the advantages and disadvantages of metaphors in design simply because they had to select the most important and essential sections about such metaphors from the article they were editing.

It is important that each “game” is perceived, and engaged in, by the learners in a serious manner.³⁶ That is, it must be understood and executed as constructive play. One has evidence of whether or not this understanding is present depending on how quickly learners get on with a play exercise and by the manner in which they settle down for debriefing after it is over. Controlling such a constructive play process is perhaps one of the most challenging of the facilitator’s tasks, and requires total congruence on the part of the facilitator about the value of engaging in such an exercise.

The same effect of distracting of attention and can be achieved through the strategic use of surprise. The very act of realizing that things are not as they had been perceived or expected generates a mental state conducive to remembering.

³⁴ Macrae and Macleod (1999). A recent study in the U.K. demonstrated that cramming actually blocks memories and induces forgetfulness.

³⁵ Lozanov (1978).

³⁶ Lozanov and Gateva (1988).

As an example, in one of the large group interactions (lectures) on the HCI course we roped off the top half of the lecture theatre and hung “Wet Paint” signs from the ropes. This generated significant amounts of surprise among the students who came to that session. Through the use of this simple device, many key concepts were picked up by learners (as documented in their diaries) including the power of labels, how labels can constrain thinking, etc.

3.3.13 Facilitating environment

People tend to perform to the level that is expected of them. An Integron is designed as an environment in which an appropriate mode of instruction is guidance and facilitation.

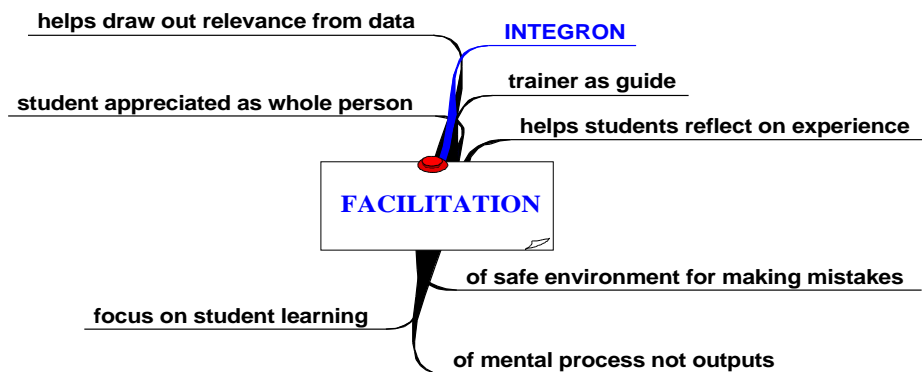


Figure 17. An Integron and facilitation

Facilitating requires a positive and accommodating attitude towards learners. We can guide the whole person development of the learner if we appreciate the learner as a whole person irrespective of the degree to which this happens to be true at any given time. We can only help learners develop mental tools for solving problems and to acquire life long learning attitudes if we focus on providing an adequate environment in which such skills can be practiced. This calls for debriefing skills, skills related to controlling the group dynamics and even some counseling skills at times. It also requires knowledge and awareness of how people learn and calls for greater flexibility for the learning facilitator to be able to stay always in control of a dynamically evolving learning process. These skills are necessary because the environment we create for the learners to change must be safe for them to make mistakes.

In order to convey this message to learners, in the HCI course one of the first things we taught them was the importance of feedback to all dynamic systems that have a clearly defined performance goal. We asked them to pour water from a bigger to a smaller container when blindfolded. While some learners were engaged in the task, other learners were asked to observe what was happening. All the water pouring learners instinctively helped themselves by using their sensory inputs other than vision: some kept putting a finger into the smaller cup, others placed their fingers on top of the cup, still others asked their observing friends for guidance, etc.

Once the learners understood that this behavior was involuntary and that feedback was a necessity if one wanted to achieve one's target, we could easily convey to them that interim coursework comments, marks or grades were no more than another form of feedback. We also told them that interim marks or comments would not be taken into account in the final assessment (with the exception of a pre-test). Thus, in an Integron, failure was never a failure once and for all. Indeed failure is necessary in order for the learners to succeed better.

3.3.14 Motivation

Within the context of the HCI course, in order for the learners to accept failure as feedback we had to create in them a strong desire to improve and a commitment to progress. In other words, in order to maximize learning outcomes we needed to ensure that the learners were intrinsically motivated.

In our course, to achieve this we had to break their old habits and approaches to learning. Initially we did that by simulating an environment that repressed the learner states (in ways analogous to baby states at birth or to being thrown in the middle of a desert and asked to survive).

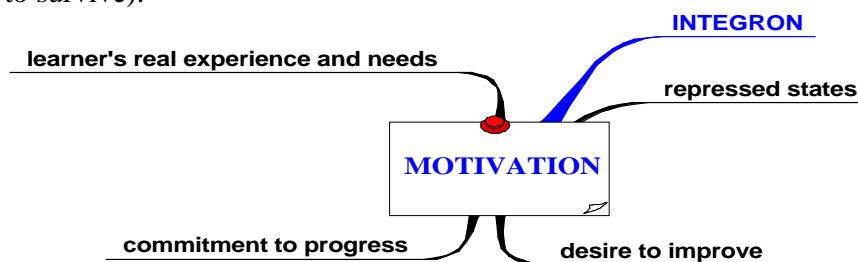


Figure 18. An Integron and motivation

For this purpose we exploited the already existent situation, namely, our course being a core program course, which made it pointless for the learners to drop out in mid term. Another factor in our favor was the university regulation that the learners had to take and pass the final exam. This allowed us in the first five weeks to give the learners only that amount of information about the course that was sufficient to keep them curious but not enough for them to fully understand all of its aims and objectives. At the same time we destroyed their expectations for ‘normal’ university type of tuition by having them sit an exam (pre-test) in the first lecture or asking them to perform brain gym, the left-right brain coordinating physical exercises at tutorials, or sending them to the library and the bookshop to look for any books on interface design they felt would be best suited to their individual learning needs and styles (see also section 3.3.9).

The effect was enormous. All the learners extensively searched for books and spent weeks discussing vigorously among themselves (as reported in the diaries) what they thought we expected of them in this course. They also tried to figure out how best to proceed in order to succeed. It was only in week five that we provided them with a clear marking scheme, the target design skills they had to acquire, and the relevant practice opportunities for acquiring those skills.

3.3.15 Attitudes and affects

An Integron puts learners on the spot but gives them all the support they need to respond to frustrations in a positive manner. It is therefore important that learners are trained early on in giving such support to each other.

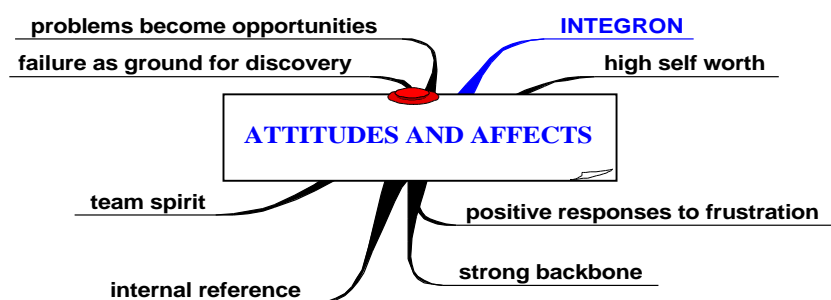


Figure 19. An Integron and affects

For this to happen, within the context of the HCI course we used the pre-test result to divide the tutorial groups into smaller assignment groups. There were four categories of learners to consider depending on which skills relevant to interface design the learners already possessed: an ability to draw, an ability to write text, an ability to think in terms of larger system components, and an ability to include the user as the central element of design. Each small group comprised one member from each of these categories.

We explained to the learners that we had chosen this method of grouping them because every one of them had something valuable to offer and to teach the remaining members of the group. Everyone could contribute to the group's overall success. Apart from this, the learners were encouraged to find answers to problems themselves before seeking help, explanation or advice from their classmates, and only in the last resort should they come for help to the learning facilitator. In teaching and providing explanations to other learners many learners learnt faster themselves and at the same time were developing higher self esteem.

Observing the self-reflective nature of the course Integron, we as facilitators have adopted an attitude of turning performance “disasters” into strengths. Every failure of technology became a source of discovery and every problem the learners encountered an opportunity for their personal improvement. For instance, our less successful lecture presentations became examples of badly designed interfaces and provided an excellent material for class discussions.

Similarly, when some learners approached us about their team problems, we kindly asked to tell us what they themselves proposed to do about that situation or problem and we then sent them back to explore their suggested solutions.

3.3.16 Mental process

An Integron provides an environment focussed primarily on the development of the mental process itself.

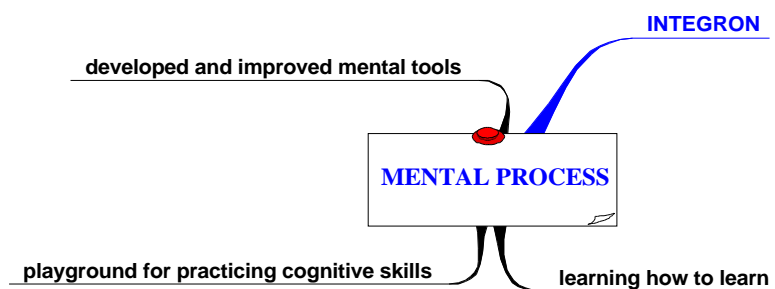


Figure 20. An Integron targets mental process

The learners are not presented with numerous facts, model solutions to well-structured problems, textbook lists, relevant pages of chapters to read for them to memorize and reproduce at exam time. (This should not be confused with clear instructions of what they are to do during tutorial or lecture activities or in their assignments, which were provided.)

In the Integron methodology, the main emphasis in teaching falls on how to observe better, how to *allow insight*, how to reason with ease, abstract, visualize, compare things, create, etc. Learners are thus encouraged to develop the skills and mindset which will underpin their own development as they increasingly learn to make sense of the world.

As mentioned earlier, the material covered by the syllabus of the HCI course was often taught in a more indirect manner than in the previous years. However, this material itself became a tool for training the (meta)cognitive process.

To facilitate multileveled cognitive development we have used a variety of different technologies discussed in more detail in section 3.3.17 below. Suffice it to say here, we have combined different technologies with respect to their simultaneous impact on visual, auditory, and kinesthetic sense perception and the role each played in the development of perceptual, intellectual, emotive, memory, and motor-movement skills.

In as much as it was possible at the micro-level we had designed and sequenced or embedded the course related Integrons in the way that ensured activating all the learners' physical and mental makeup at the same time and keeping it active most of the time.

3.3.17 Resource technologies

The Integron Methodology utilizes existing educational technologies in ways that are truly learner centered and that support human needs for transforming internal states. Some examples of what we mean by this are outlined below.

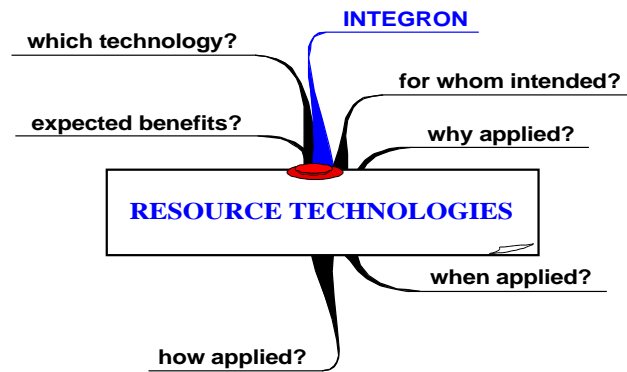


Figure 21. An Integron and resource technologies

Metaphor

Bearing in mind the power of metaphor to help people both learn and transform³⁷, in the HCI course everything became an interface, i.e. the course itself became a metaphor for what it was teaching. Also, everything became a metaphor. There were interfaces within interfaces within interfaces and metaphors within metaphors within metaphors. (see Figure 22) In fact, metaphor became a building block of the course Integron. It helped bring seemingly unrelated domains to the learners' conscious awareness thus facilitating their creative leaps and providing an environment for them to formulate interesting questioning questions (see also section 3.3.9).

³⁷ Lankton C.H and Lankton S.R. (1989); Kopp R.R. (1995); Gordon D.A (1978).

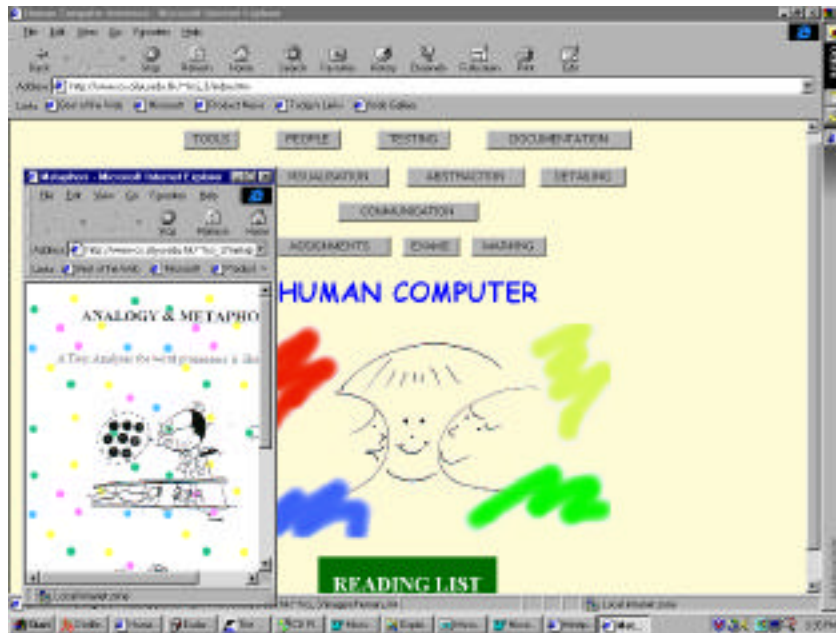


Figure 22. Embedded metaphors

For example, we used a metaphor of a windows application to design a web page for introducing the topics and content of the course (Figure 23). This same page contained an embedded window that presented the learner with a definition of a design metaphor. Thus we used metaphor as a presentation tool for teaching metaphors as part of theory for HCI. Such embeddings also allowed us to interface different information processing modalities in the learners minds at the same time.

Powerful iconic presentation

For the HCI course we developed iconic PowerPoint slides that presented some points visually instead of the corresponding earlier text versions. Language based information was delivered orally to accompany a corresponding iconic slide, but we were very careful *not to explain or describe the icons*. In this way we anchored verbal information and concepts to images that were easier to remember.³⁸

³⁸ Packard (1988).

Music as a state modulating tool

Since remembering and learning happens better and faster in relaxed states³⁹, we used baroque music for “tuning in” the learners’ brain cycles⁴⁰ while more popular music helped us keep the learners more alert whenever to do so was appropriate. This technique generated a much tighter cognitive fit between the external input and the nature of the learners mental tasks. Often, it helped simulate a home-like environment for learning.

Conscious design of the learning space

Another dimension in combining various technologies relates to how these help distribute information that will be accessed in a direct interaction with an environment and information that will be made available only to one’s peripheral vision or received as a background noise. The posters (mentioned in section 3.3.5) on the classroom walls are the case in hand. In spite of the fact that these posters were displayed on the walls throughout the course, the learners were only asked to study them carefully in the last tutorial session. Thus, the information the learners (must) have unconsciously been registering all along was in fact repeated and reinforced and not introduced formally for the first time until that last session.

Posters and sensory enrichment

Apart from the visual and auditory inputs the learners were continually actively involved, especially at tutorial time. They had to physically interact with a variety of objects and operate in the same physical space with other learners. Many such sessions had several stations in the room with a different activity at each station. The learners had to visit all of those stations one by one. During such activities they were developing motor-movement skills relevant to designing.

³⁹ Goleman, D. (1995).

⁴⁰ Lozanov and Gateva (1988); Lozanov (1978); Schuster,D.H.. and Gritton, C.E., (1985).

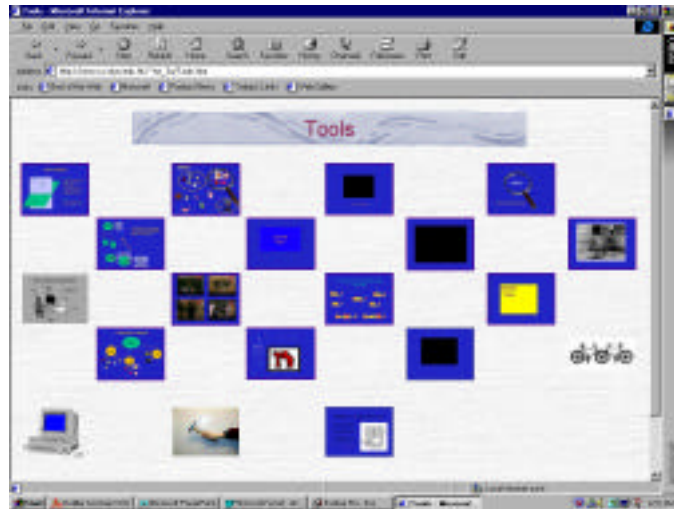


Figure 23. Thumbnails for mental hyperlinking

Having to perform difficult team tasks in a short period of time, the learners did not only have to cope with processing the visual, tactile, and kinesthetic sensory input but also had to attend to emotional states that interacting with their classmates had brought to the fore.

Simple tools

In many tutorial activities learners used only pens and paper – a very effective and flexible combination for making one’s design ideas external for others to look at or for organizing one’s thoughts better. What mattered more in those exercises, however, was the speed with which the chosen tools were used and not how modern or complex they were.

Communication disseminating technologies

It is fashionable these days to use the Internet and Intranet for distributing course material to learners. When this medium is used merely to replace more traditional hardcopy handouts of lecture slides, its only advantage is in saving learning facilitator resource time and reproduction costs. The Net also provides ready access to the world’s new factual encyclopedia – the Web. In this project, however, we have begun to experiment, informally, with one specific characteristic of the Web, namely, hyper-linking and how this property can be utilized to support metacognitive training.

We constructed a separate site intended to help our learners better integrate past material by having to generate their own hyperlinks across different HCI topic domains. To facilitate this process, every page in the site contained a number of unordered thumbnails of a single PowerPoint icon each, that had been shown at lecture time. However, the information in the icons on a page did not correspond to one lecture presentation. Instead, it was organized thematically and usually contained a mixture of icons from different lectures. Due to this re-organization, some icons appeared on more than one page.

An instantly obvious advantage of the use of this Web site was its interesting methodological side effect: visiting the site could not become a substitute for attending lectures. The information from all the lectures was there, but a learner who had missed some lectures was unlikely to benefit to the same degree from using this site as the learner who fully participated in all of the activities offered by the course.

Many more controlled experiments are needed to test the use of each above mentioned technology for its intended cognitive outcomes than has been possible to tease out in this pilot study. What has to be remembered in using technology in Integrons is that each technology is an instrument for dissociating participants, while the essential purpose of an Integron is to associate.

The Use of Presuppositions in Language

Natural language is itself a tool, which can be creatively applied to facilitating the learning process. Within the Integron Methodology we made use of presuppositions (both verbally and non-verbally) that suggested to students that they could learn, be creative, master the course material easily, etc. Presuppositions used in this way are important to suggestopedia⁴¹ and have been shown to be important elements supporting change in people⁴².

⁴¹ Lozanov and Gateva strongly stress the importance of positive presuppositions to the learning process. Lozanov, G. and Gateva, E. (1988)

⁴² Bandler and Grinder (1975)

3.3.18 Assessment

Since an Integron facilitates whole person development, there must be a variety of different types of assessment to account for learner progress. The Integron methodology uses assessment as a motivating factor: it rewards good effort. The difference to traditional teaching is in the type of effort it aims to reward.

Following the general principle that one normally gets what one “pays for”, within the HCI course we rewarded a noticeable development of “mission critical” (meta)cognitive skills that we had defined at the onset, namely the quantity and quality of observations, insights, and creative design outputs. In other words, assessment was built into the course in such a way as to focus conscious attention onto those activities which would inevitably lead to development in the skills of our learners.

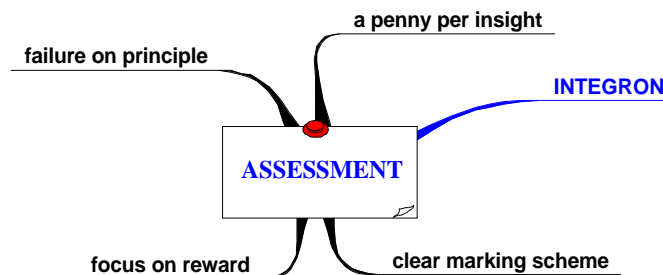


Figure 24. An Integron and assessment

Focus on activity, not outcome

In order to move our learners away from consciously trying to “cram” facts for their exam, we decided that we would use assessment criteria as a way of focusing their attention on the course. To do this, early in the course our students were informed that they had to score not less than a C grade in each coursework assignment and that the coursework mark was weighted 60% with respect to the overall course grade.

Focus on improvement, not absolute knowledge

Graded coursework comprised two assignments and two internal tests. The two internal tests were organized as combination of a pre-test and a post-test, and our learners were informed that they would be graded based on how they improved between the first and the second test. We did this so as to focus the attention of all learners on their own improvement, and the specific things they would need to learn in order to build their skills.

In terms of content, these tests contained a request for learners to design a main interaction screen for an application. The difference between the first and second test was used to determine the percentage of metacognitive improvement. What we were monitoring was a broadening of the range of modalities used (e.g. text + drawing) and the degree and nature of the proposed user-system interactions: i.e. Could the learners communicate how the computer was intended to fit into the user's everyday tasks?

Focus on skill development

As discussed earlier, the development of specific learner skills (especially cognitive and perceptual skills) was deemed to be critical to achieving satisfactory outcomes in the course. Consequently, students were graded on their practice of desired skills. In order to capture relevant information, one assignment was a "Leonardo Da Vinci" Diary for reporting on everyday observations, insights, doubts, questions and notes about the issues in HCI. This diary comprised a free noting and a formal section.

To encourage self learning (and to show the learners that it was possible for all to become self learners) we organized a bibliography competition for the tutorial groups. Tutorial groups had to submit a list of references to the relevant literature they had read each week and to supplement each entry with a short summary of content and evaluation of its usefulness to the course. The submitted references were published internally on the HCI Web site. Initially the winners were to be rewarded with a prize. In the final account they were awarded additional five marks towards the overall coursework mark.

Focus on application of knowledge

In our view, learners knowing *about* HCI was not as important as learners being able to *apply design principles*. We viewed the formal section of the "Leonardo Da Vinci" Diary as being an interface between a writer and a reader, and therefore subject to the principles

of interface design. The formal section, therefore, was intended to provide a demonstration of how the learners were able to organize their free notes into a coherent set of summaries of topics relevant to HCI, and present these in a user friendly way.

This experience also provided a platform for the learners to learn how to integrate the knowledge of HCI with the surrounding world, and as a result of such anchoring, to be able to remember the concepts better. The quality of outputs was assessed on the scale of 1 to 10.

In addition to the diary assignment, in a group project the learners were requested to design an interface to a Masterful Learner – an application that was to help learners at the City University of Hong Kong learners to learn better and faster. In this assignment our learners had to investigate the real users' need for accelerating learning. This forced them to think in depth about how people learn and to do an empirical study (with questionnaires and interviews) of how their colleagues at the university learnt. In the process, the learners had uncovered, and some had evidently modified, their own learning habits. They also learnt how to share ideas with other learners, how to negotiate a group work outcome, and how to be good members of a team (all of which are very relevant skills for a person soon to join the work force).

In the group assignment they were rewarded according to a list of twenty usability criteria for documentation and the way they were able to apply design principles in practice: Could they abstract more general properties from the specific samples? Could they re-specialize those general properties using different modern application technologies? Had they used sketches, diagrams, metaphors, and so on?

Re-framing learner perception of grades

In order to take away the stigma attached to the lower grades, we redefined them as follows:

- A = A new start
- B = Beginning to understand
- C = Coming closer
- D = Dig deeper
- E = Effort required
- F = Feedback

As mentioned earlier (section 3.3.8), the interim grades served as feedback only.

Section 4

THE IMPACT OF THE INTEGRON METHODOLOGY

When we began this project in early 1999 it was our intention to 1) test the effectiveness of the Integron Methodology and 2) to generate guidelines so that this methodology can be more easily adopted for use by teachers in the tertiary environment in Hong Kong.

The effectiveness of the methodology can be evaluated along various different dimensions. For this study we were primarily interested in the impact of the methodology on Whole Person Development of the student (See section 1.1.2) as well as on student mastery of the HCI curriculum.

In order to evaluate these different elements we made use of both qualitative and quantitative approaches. A qualitative approach was used to evaluate the new methodology in terms of the observed impact on student's Whole Person Development. In order to evaluate the Integron methodology's impact on student mastery of the HCI curriculum we elected to make use of a quantitative comparison of performance on the final examination between the cohort exposed to the Integron Methodology and two other student cohorts.

4.1 A Quantitative Evaluation of Student Performance

To do a quantitative comparison evaluation of the impact of the Integron Methodology on student learning we compared the exam performance of students exposed to the new Integron Methodology (the 1998-99 CS cohort –114 people) with the exam performance of two other student cohorts who were exposed to the university curriculum used for the HCI course in previous years. (See Table 1, Pp. 24-25, for comparison.) As mentioned earlier, the two other cohorts were second year Computer Science (CS) undergraduates in the preceding academic year 97/98 (the 1997-98 CS cohort – 98 people) and the third year undergraduates of the Chinese, Translation, and Linguistics (CTL) in the concurrent academic year 98/99 (the “Linguists” – 37 people).

We decided that this between-cohort comparison was the best way to test for mastery of course content without actually setting up a controlled experiment within the same group of students in the same year.

Given that we were comparing a student group from a previous year, and a student group from a different department, with the 1998-1999 CS cohort, comparing exam performance was considered the best way to control for conditions between cohorts and years. This is at least true for comparing levels of mastery on the core curriculum because of the relative consistency of conditions that students need to face in an exam environment.

In future it will, of course, be possible to compare different groups across many more dimensions.

While it might be argued that holistic learning is not fully reflected in exam performance, student exam scores can at least be taken as a surrogate measure for the amount of course related material that students have learned in a course. Exam scores reflect on student's ability to access and apply their learning under stressful conditions. This applies, at least, to examinations whose content reflects the course content. For more details on a wide range of assessment techniques see Miller et al⁴³.

For the purpose of comparison across cohorts we decided **not** to make use of course performance or overall grade. Our rationale for this is that the requirements and contexts for most elements of coursework were quite different in each year, and between cohorts, therefore making it inappropriate to compare scores given to students in different groups and different years. Consequently, we also did not use overall course grade as a means for comparison due to the impact of coursework on the overall grade.

The final comparison that we made was between student performance on the pre-test and the post-test, both for the 1998-99 CS and Linguist cohorts.

⁴³ Miller , Imrie and Cox (1998).

4.2 Hypotheses for Quantitative Comparison between Cohorts

Our general hypothesis concerning the application of the Integron Methodology to learning at City University is that students exposed to this instructional methodology should, on average, learn more of the course content, and be better at applying this, than students not exposed to the Integron Methodology.

In order to test this hypothesis we carried out a range of comparisons, which were tested for statistical significance. Comparisons used included:

4.2.1 Overall Exam Score Comparison

A comparison of overall OFFICIAL exam scores for HCI student cohorts in 1997-98, 1998-99 and the 1998-99 Linguists HCI cohort. In this comparison it is important to note that class contact time for the 1998-99 HCI cohort and the 1998-99 Linguists cohort was only two thirds of that experienced by the 1997-98 HCI Cohort .

For this comparison our specific testing hypotheses were as follows:

- If the Integron Methodology supports student learning of HCI related course material, examination performance of the 1998-99 CS cohort should be, on average, significantly better than that of the 1998-99 Linguist Cohort.
- If the Integron Methodology supports student learning of HCI related course material, examination performance of the 1998-99 CS cohort should be, on average, be AT LEAST AS GOOD AS, or significantly better than, that of the 1997-98 CS cohort. Please note that, given the difference in formal contact hours, an *equivalent performance* level on the exam by these two cohorts does, in fact, *represent* an *increase* in performance/unit contact time by the CS 1998-99 cohort compared with earlier years.

4. 2. 2 Comparison with “Unofficial” Exam Score

Our second comparison involved using the UNOFFICIAL exam score for the CS 1997-98 student cohort and the OFFICIAL exam score for the 1998-99 HCI student cohort. The unofficial score for the 1997-98 HCI cohort was made up of remark scores⁴⁴ for two very similar questions that were used in both 1998 and 1999 along with the original official score for the two questions which were substantially different in 1998 and 1999.

For this comparison our specific testing hypothesis was as follows:

- If the Integron methodology supports student learning of HCI related course material, examination performance of the 1998-99 CS cohort should be, on average, be AT LEAST AS GOOD AS, or significantly better than, that of the 1997-98 CS cohort. Again, please note that, given the difference in formal contact hours, an equivalent performance level on the exam by the two cohorts does, in fact, represent an increase in performance/unit contact time by the CS 1998-99 cohort.

4. 2. 3 Comparison on Specific Exam Questions (Official)

As mentioned in footnote 43 above, in order to increase the comparability between this year’s cohort and last year’s cohort, two of the exam questions for the 1998-99 cohort were designed to be as close as possible to two questions from the previous year (1997-98). One of these questions concerned the use of design metaphors, and the other was on usability.

The opportunity to directly compare performance on specific exam questions that represent core course material allows us to examine the extent to which core learning outcomes (i.e. curriculum goals) were achieved across the different cohorts. As with the comparison of the entire exam, an equivalent performance of the two groups on these exam questions would, in fact, represent faster/deeper learning by the 1998-99 cohort (because they would have achieved the same results with a lower number of formal contact hours).

⁴⁴ In any marking process there is a degree of subjectivity operating on the part of the marker, especially for a topic such as design where there is no “right” answer. Consequently, in order to increase the degree of comparability between the 1997-98 HCI cohort and the 1998-99 HCI cohort, two questions from 1997-98 which were, in essence, repeated in the 1998-99 exam were remarked using exactly the same marking criteria as used for the 1998-99 cohort. These criteria were very detailed and very specific, and were documented prior to carrying out the marking.

Also, it is important to note that, while being very similar in form, the metaphor question prepared for the 1998-99 cohort was actually more difficult than that for the 1997-98 cohort as it related to problems that were unlikely to be in the direct experience of the students. Therefore, similar performance on this question between the two groups would, in fact, represent greater attainment by the 1998-99 cohort (exposed to the Integron Methodology).

4. 2. 4 Comparison on Specific Exam Questions (Unofficial – using remark scores) in Different Years

We also used the unofficial, remark scores for the exam for the 1997-98 cohort and compared performance with the 1998-99 cohort.

4. 2. 5 Comparison Between the two 1998-99 Cohorts

We also decided to make a direct comparison in exam performance between the 1998-99 CS and Linguist groups. Both groups were given the same exam questions, and both were exposed to the same course content. The major difference was the method of instruction.

The hypothesis for this comparison was that, assuming the effectiveness of the Integron methodology, the 1998-99 CS cohort should perform better on the exam than the 1998-99 Linguist cohort.

4. 2. 6 Pre-Test/Post-Test Comparisons

The final quantitative comparison that we decided to make was between student performance on the pre-test and on the post-test that were used during the course for both the CS and Linguist groups in 1998-99. A pre-test was given on the first day of the course and was used to provide a baseline of student performance, and students' mental models about the course.

The post-test was given two weeks before the end of the course, under similar conditions as the pre-test.

Our hypothesis was that, if the Integron method of teaching is effective, students exposed to the method should show a greater propensity to change their mental models than students not exposed to the methodology. Specifically, the Integron methodology should lead to students internalizing a multi-dimensional model of the communication process between a user and an interface.

For the test of this hypothesis we compared changes in the CS 1998-99 cohort with those made by the Linguist 1998-99 cohort. The comparison was made as follows:

Both the pre and post-test consisted of a design question, requiring the student to do a basic design and communicate it using drawings and descriptions as appropriate. In marking, the pre-test and the post-test for each student were compared together, and the way in which each student communicated his/her answer to the question was graded based on the qualitative changes made between the pre and post test. Based on the comparative difference in the way a student communicated his/her design, he/she was placed into one of five different categories. The five categories used were as follows:

Category	Label	Description
1	No Change (given a base of 30 points)	If no difference was noted between the first and second test, the student was placed into the No Change category.
2	Drawing (given 50 points)	If, on the first test, the student used mostly a text based interface while on the second test he/she did more drawings, and generated more iconic representations, the student was placed into the drawing category.
3	More Interactive (given 60 points)	If the difference between the first and second test showed an increase in the interactivity of the interface, the student was placed into the interactive category
4	Whole design process interactive (given 70 points)	If, based on how this was communicated, it was clear to the marker that the student had migrated to a state where the whole design process was interactive, he/she would be placed into this category.
5	Internalised multidimensional model (given 80 points)	If the student clearly had internalised a multi-dimensional model of the communication process that takes place between a user and an interface, he/she was placed into this category.

Table 2. Categories for assessing degrees of student improvement

Assuming that the hypothesis is correct, i.e. that the Integron Methodology supports greater change in internal mental models for a given subject than does standard teaching, we would expect that the students exposed to this method would more likely show a move to category 5. Therefore, more of the CS 1998-99 cohort should move into category 5 than the 1998-99 Linguist cohort.

4.3 Analyses of Quantitative Comparisons

4.3.1 Comparison 1 and 2. – Comparing Official/Unofficial Exam Scores with the Integron Group

The following table shows the differences in grade distributions on the final exam for each of the different cohorts outlined above. We have placed the grades into five bins, representing the “A” band, “B” band, “C” band, “D” band and “F” band. The “A” band runs from A- to A+, the B band from B- to B+, and the C band from C- to C+. The mapping between raw exam scores and grades was made using the CS department official grade distribution guidelines for the Credit Unit System.

Grade Bins	1997-98 CS Official Exam Score (Frequency)	1997-98 CS Remarked Exam Score (Frequency)	1998-99 CS Official Exam Score (Frequency)	1998-99 Linguists Official Exam Score (Frequency)
A- to A+	9	6	20	1
B- to B+	45	41	37	12
C- to C+	41	40	48	17
D	2	10	4	5
F	1	1	5	2
TOTAL	98	98	114	37

Table 3. A comparison of exam scores between student cohorts (raw frequency)

Comparison of Exam Results Between Cohorts

Grade Bins	1997-98 CS Official Exam Score (%Frequency)	1997-98 CS Remarked Exam Score (%Frequency)	1998-99 CS Official Exam Score (%Frequency)	1998-99 Linguists Official Exam Score (%Frequency)
A- to A+	9%	6%	18%	3%
B- to B+	46%	42%	32%	32%
C- to C+	42%	41%	42%	46%
D	2%	10%	4%	14%
F	1%	1%	4%	5%
TOTAL	100%	100%	100%	100%

Table 4. A comparison of exam scores between student cohorts (% frequency)

As can be clearly seen (table 3 and 4), the 1998-99 CS cohort (which is the cohort exposed to the Integron Methodology) has a much higher percentage of students in the “A” band than any of the other cohorts.

In comparing the exam performance of students across different cohorts it was necessary to decide upon an appropriate statistical methodology for testing whether or not any observed difference were statistically significant. We had initially intended to use a t-test to check the statistical significance of differences between groups. However, examination of the data revealed that it was not normally distributed for either the 1998-99 HCI cohort or the 1998-99 Linguist cohort. The t-test cannot be employed in such a situation.

As a consequence, we decided to use the χ^2 (Chi-Square) test of Independence which is a distribution free test, i.e. it does not require the data to follow a normal distribution in order to be valid.

The comparisons between the 1998-99 CS cohort, and the other cohorts chosen, generated the following χ^2 results:

	CS 1997-98 Official Exam Scores	CS 1997-98 Remarked Exam Scores	1998-99 Linguist Exam Scores
χ^2 Value for comparison with the 1998-99 HCI cohort	7.83	14.23	10.07
Critical χ^2 value for 4 d.f. at 90% level	7.78	7.78	7.78
Critical χ^2 value for 4 d.f. at 95% level	9.49	9.49	9.49
Critical χ^2 value for 4 d.f. at 99% level	13.28	13.28	13.28
Level of significance	90%	99%	95%

Table 5. Statistical significance of comparisons of exam scores across cohorts

As can be seen from the above table (5), there is a statistically significant difference between the grade distributions of students exposed to the Integron Methodology and both the 1998-99 Linguist group (95% level) and the 1997-98 CS group with remarked exam questions (99% level).

There is also a difference between the distribution of exam grades of the 1998-99 CS group and the distribution of Official grades for the 1997-98 CS group, but this is only significant at the 90% level. This is, of course, still meaningful given that the 1998-99 cohort had 30% less class time than the cohort from the previous year.

In conclusion, we are able to say with confidence that the Integron Methodology helped students to perform better on the exam overall than the other groups when similarly stringent marking criteria were used, and at least as well as the “Official” performance of the 1997-98 CS group, even though teacher contact time for the 1998-99 CS student cohort was 30% less than for last year’s cohort.

4. 3. 2 Comparison 1 and 2. – Comparing Official/Unofficial Exam Scores with the Integron Group Using a Fine Filter

In the above test for significance we made use of five grade bands A- to A+, B- to B+, C- to C+, D and F. In order to further explore the impact of the Integron Methodology on the distribution of grades in different cohorts we also tested the statistical significance levels for a finer filter for the grade bins. With this filter we spread student grades into grade bins of A+, A, A-, B+, B, B-, C+, C, C-, D and then tested the distribution differences for significance.

From a practical point of view, using this fine a filter may not be the most appropriate because exam marking has a degree of subjectivity, and the difference between bins (e.g. B and B+) is often very subtle. In terms of evaluating student performance, more meaningful categorizations probably occur between the broader bands of A's, B's, C's, etc. However, for thoroughness, we did make use of the finer filter.

When filtered this finely the distribution differences between the groups were overall not statistically significant at the 95% level however the difference between the 1997-98 cohort (with remarked exam questions) and the 1998-99 CS group exposed to the Integron Methodology was significant at the 90% level (Table 6).

	CS 1997-98 Official Exam Scores	CS 1997-98 Remarked Exam Scores	1998-99 Linguist Exam Scores
² Value for comparison with the 1998-99 HCI cohort	15.85	17.13	10.50
Critical ² value for 10 d.f. at 95%	18.31	18.31	18.31
Critical ² value for 10 d.f. at 90%	15.99	15.99	15.99
Level of significance	Not Significant	90%	Not significant

Table 6. Statistical significance of comparisons of exam scores across cohorts (fine filter)

4.3.3 Comparisons 3, 4 and 5. Comparison of individual exam questions

As discussed above, we compared performance of the different student cohorts on a question-by-question basis in the exam. The results of that comparison are presented below.

Comparison of exam question on usability

From the tables 7 and 8 below it can be seen that the student cohort exposed to the Integron Methodology obtained a greater number of A grades on this exam question than any of the other cohorts. Overall, there appeared to be a “push” in the distribution towards the higher grades compared to the other student cohorts.

	1997-98 CS Usability Exam Question (official)	1997-98 CS Usability Exam Question (remarked)	Linguists 1998-99 Usability Exam Question	1998-99 CS Usability Exam Question
A- to A+	32	34	13	51
B- to B+	31	22	10	31
C- to C+	24	21	5	17
D	5	8	1	5
F	6	13	8	10
Total Students	98	98	37	114

Table 7 A comparison of scores on usability exam question (frequency)

	1997-98 CS Usability Exam Question (official)	1997-98 CS Usability Exam Question (remarked)	Linguists 1998-99 Usability Exam Question	1998-99 CS Usability Exam Question
A- to A+	33%	35%	35%	45%
B- to B+	32%	22%	27%	27%
C- to C+	24%	21%	14%	15%
D	5%	8%	3%	4%
F	6%	13%	22%	9%
Total Students	100.00%	100.00%	100.00%	100.00%

Table 8. A comparison of scores on usability exam question (% frequency)

This difference in the distributions was, however, not statistically significant (see Table 9 below).

As with the overall exam score there was a non-normal distribution of scores for this question. Hence we used a χ^2 Test for Independence to test for the statistical significance of the observed difference.

	1997-98 Usability Exam Question (official)	1997-98 Usability Exam Question (remarked)	Linguists 1998-99 Usability Exam Question
χ^2 Value for comparison against the 1998-99 HCI cohort	4.56	4.19	3.89
Critical χ^2 value for 4 d.f. at 90% level	7.78	7.78	7.78
Level of significance	Not Significant	Not Significant	Not Significant

Table 9. Statistical significance of comparisons of exam scores on usability question across cohorts

Comparison of exam question on design metaphors

From the tables 10 and 11 it can be seen that, on the official exam score, the 1997- 98 CS cohort performed better than any of the other cohorts in terms of the number of A’s and B’s attained for this question. Using the χ^2 Test of Independence this difference was significant at the 99% level.

	1997-98 metaphor EXAM Question (official)	1997-98 metaphor EXAM Question (remarked)	Linguist Metaphor Exam Question	CS Metaphor Exam Question
A- to A+	31	16	6	17
B- to B+	25	25	5	17
C- to C+	15	27	9	29
D	5	3	8	8
F	22	27	9	43
	98	98	37	114

Table 10. A comparison of scores on metaphor exam question (frequency)

	1997-98 Metaphor Exam Question (official)	1997-98 Metaphor Exam Question (remarked)	Linguist Metaphor Exam Question	CS Metaphor Exam Question
A- to A+	32%	16%	16%	15%
B- to B+	26%	26%	14%	15%
C- to C+	15%	28%	24%	25%
D	5%	3%	22%	7%
F	22%	28%	24%	38%
	100%	100%	100%	100%

Table 11. A comparison of scores on metaphor exam question (% frequency)

	1997-98 CS Metaphor Exam Question (official)	1997-98 CS Metaphor Exam Question (remarked)	Linguist 1998- 99 Metaphor Exam Question
2 Value for comparison with the 1998-99 HCI cohort	16.93	6.56	6.97
Critical 2 value for 4 d.f. at 90% level	7.78	7.78	7.78
Critical 2 value for 4 d.f. at 95% level	9.49	9.49	9.49
Critical 2 value for 4 d.f. at 99% level	13.28	13.28	13.28
Level of significance	99%	Not Significant	Not Significant

Table 12. Statistical significance of comparisons of exam scores on metaphor exam question across cohorts

It should be noted again here that the question used this year, though of the same type, was likely much more difficult for students as it contained elements that were most probably not within the everyday life experience of most of the students.

Comparison of exam question on conceptual models

For this question on conceptual models it can be seen that the 1998-99 CS cohort exposed to the Integron methodology were able to perform better than the 1998-99 Linguist cohort. Looking at the percentages it can be seen that the distribution has clearly moved upwards towards the higher grades in the CS cohort who were exposed to the Integron Methodology.

As with the questions above, the distribution of grades for this question was also non-normal. Hence we again used a χ^2 Test of Independence to examine the level of statistical significance of the observed differences. As can be seen from the above table, the difference was significant at the 90% level and almost, but not quite, significant at the 95% level.

	Linguists 1998-99 Conceptual Model Exam Question	CS 1998-99 Conceptual Models Exam Question
A- to A+	7	30
B- to B+	6	38
C- to C+	11	21
D	9	12
F	4	13
	37	114

Table 13. A comparison of scores on conceptual model exam question (frequency)

	Linguists 1998-99 Conceptual Model Exam Question	CS 1998-99 Conceptual Models Exam Question
A- to A+	19%	26%
B- to B+	16%	33%
C- to C+	30%	18%
D	24%	11%
F	11%	11%
	100%	100%

Table 14. A comparison of scores on conceptual model exam question (% frequency)

	Linguists 1998-99 Conceptual Model Exam Question
χ^2 Value for comparison with the 1998-99 HCI cohort	9.32
Critical χ^2 value for 4 d.f. at 95%	9.49
Critical χ^2 value for 4 d.f. at 90%	7.78
Level of significance	90%

Table 15. Statistical significance of comparisons of exam scores on conceptual model exam question across cohorts

	Linguists Design Software Interface Exam Question	CS 1998-99 Design Software Interface Exam Question
A- to A+	4	20
B- to B+	9	39
C- to C+	10	28
D	2	14
F	12	13
	37	114

Table 16. A comparison of scores on software interface design exam question (Frequency)

4.3.4 Comparison of software interface design exam question

For the design question, the CS 1998-99 Cohort had many more students performing well on this question than did the Linguist group. Over half of the CS 1998-99 students fell into the “B” bin and above, whereas only 35% of the Linguists achieved this outcome.

As with the questions above, the distribution of grades for this question was also non-normal. Hence we again used a χ^2 test of independence to examine the level of statistical significance of the observed differences. As can be seen from the table below (18), the difference was significant at the 95% level.

	Linguists 1998-99 Design Software Interface Exam Question	HCI 1998-99 Design Software Interface Exam Question
A- to A+	11%	18%
B- to B+	24%	34%
C- to C+	27%	25%
D	5%	12%
F	32%	11%
	100%	100%

Table 17. A comparison of scores on software interface design exam question (% Frequency)

	Linguists 1998-99 Design Software Interface Exam Question
χ^2 Value for comparison with the 1998-99 HCI cohort	11.25
Critical χ^2 value for 4 d.f. at 95% level	9.49
Critical χ^2 value for 4 d.f. at 99% level	13.28
Level of significance	95%

Table 18. Statistical significance of comparisons of software interface design exam question across cohorts

	Linguists Pre/Post test Improvement	HCI 1998-99 Pre/Post Test Improvement
No Change	10	32
Drawing	10	16
More Interactive	12	33
Whole design process interactive	5	16
Internalised multidimensio nal model	1	17
Total Students	38	114

Table 19. A comparison of change scores on pre and post test. (Frequency)

4.3.5 Comparisons 6 – Improvement between pre-test and post-test

The comparison of the change between the pre and post test for the Linguists and the HCI 1998-99 cohort (tables 19, 20 and 21) generated the following results.

	Linguists Pre/Post test Improvement	HCI 1998-99 Pre/Post Test Improvement
No Change	26%	28%
Drawing	26%	14%
More Interactive	32%	29%
Whole design process interactive	13%	14%
Internalised multidimensional model	3%	15%
Total Students	100%	100%

Table 20. A comparison of change scores on pre and post test (% Frequency)

	Linguists Pre/Post test Improvement
χ^2 Value for comparison with the 1998-99 HCI cohort	4.12
Critical χ^2 value for 1 d.f. at 95% level	3.84
Critical χ^2 value for 1 d.f. at 99% level	6.63
Level of significance	95%

Table 21. Statistical significance of comparison of change scores on pre and post test between cohorts

From Table 20 above it can be clearly seen that a much greater percentage of the students exposed to the Integron methodology were able to demonstrate a clear mind shift around the core subject material of the HCI course. 15% of the Integron exposed cohort were able to internalize a multidimensional model of the interaction between a user and an interface compared with only 3% of the Linguist cohort.

Using the χ^2 Test for Independence this difference between distributions was significant at the 95% level.

4.3.6 Conclusion on quantitative comparisons

Overall, the students exposed to the Integron Methodology were able to perform better on the exam than students in other cohorts that were not exposed to this teaching methodology.

In addition, from the comparison of the pre-test and post-test in the Linguist and CS cohort it is clear that students exposed to the Integron methodology were more likely to make a fundamental shift of mind which allowed them to understand the HCI subject matter at a much deeper level.

4.4 Qualitative evaluation

In order to evaluate the qualitative impact of the methodology we decided to examine a number of different elements, specifically student receptivity to the methodology, evidence of Whole Person Development, and evidence of shifts of mind related to the subject matter.

To identify student receptivity to the methodology we made use of the student evaluation of the course (completed by students at the last lecture), and also observed student behavior in lectures and tutorials. Student comments in their diaries (part of the course assignment) also indicated the level of satisfaction (or otherwise) with the course.

Evidence for Whole Person Development and for Shifts of Mind were gathered from our readings of the student diaries.

4.4.1 Student Evaluations of the Course

In order to evaluate the reaction of students to the new course design we initially made use of student feedback derived from the official City University Teaching Feedback Questionnaire which allows students to rate teacher performance from 1 (excellent) to 6 (very poor).

Student Cohort	Number of Students (n)	Mean Overall Satisfaction Level	Standard Deviation of Satisfaction Level
1998-99 HCI Cohort (Integron Exposed)	83	3.27	1.04

Table 22. Student satisfaction ratings

From the above Table 22 it can be seen that the average satisfaction level of students exposed to the Integron Methodology was only in the mid-range, and was in fact less than we would have expected.

It should be noted, however, that only 72% of the students in the 1998-99 student cohort completed the form. Also, they had only 3 minutes to complete their evaluations, due to a time crunch at the last session. We had a choice of allowing students to present their results to the class, or to finish early and give more time to the evaluation. As the primary philosophy of the Integron Methodology is to support student learning, we chose to forsake a more comfortable time frame for evaluation and instead give the students the experience of being successful in front of their peers.

Another point which is extremely important to raise here is that students' rating evaluations were quite different from qualitative evaluations that they made about the course in the diaries. This difference was also noted on the two occasions where we made use of mixed quantitative and qualitative questionnaires during the course, and noted a "disconnect" between the qualitative responses and the quantitative responses.

The ratings given by students also do not seem to reflect the degree of focus and interest demonstrated during both small and large group interactions. This disconnect is clearly an area that requires further investigation.

4. 4. 2 Student participation and "Emotional Energy"

Whether or not a particular teaching methodology is relevant to students can be determined in part by the behavioral reactions of the students in the teaching environment. Distraction, sleepiness, low energy, etc. are all signs that the teaching method has not captured the student's attention.

Full engagement, a willingness to try, high energy, interaction, etc. on the other hand indicate that the teaching method has been able to capture the student's attention.

In this course, we had one hour per week of lecture and one hour of tutorial. In the tutorial sessions we were able to operate very flexibly because of the choice of venue. The tutorial sessions were used to expose the students to a range of different activities which were then discussed in a debriefing process.

In all of these tutorials students were fully engaged and actively participating in the exercises that had been set up. They were fully attentive and, as they were working in small groups on most occasions, they were communicating openly and actively.

The “energy” of each of these tutorial sessions was generally very high, and often students chose to stay past the designated end of the tutorial to go further and deeper into the debriefing process.

Each of these tutorials has been recorded on videotape which provides evidence of the level of student participation generated by the methodology.

4. 4. 3 Spontaneous student comments

Another way in which we evaluated student satisfaction with the course was the reading of student diaries and identifying comments about the course that were either negative or positive. In cases where students were not happy with the course they appeared to have no hesitation in saying so in their diaries.

On a cursory count 25 of 114 students made a range of positive comments about the course in their diaries. In addition, a number of students made what we label as negative but thoughtful comments. These comments indicated that the student in question was, in fact, influenced by the course and forced to think very deeply about its meaning and relevance to him/her.

4. 4. 4 Whole person development

In order to identify the presence of whole person development we carefully read student diaries, filtering for comments / entries that pointed to the fact that the student was experiencing some element of whole person development.

The evidence criteria we chose for monitoring whole person development included: developing learning skills, participation, self management skills, self application, emotional skills, and communication skills.

Some examples of evidence from student diaries that points to deeper and whole person learning are provided below.

Learning skills

It is clear from reading the content of the student diaries that they have achieved a significant level of attainment in the following learning skills, which we support with randomly selected extracts:

Curiosity

Asking questions

‘All in all, I have a blur idea about masterful learner but still have not enough tolls to develop the whole system yet and what I need to do right now is asking the right questions.’

Inquiring with colleagues

‘According to the classmate opinion, communications, lacking of resources, books in library are the problems in the learning process in the university. I think that communications is the ultimate problem among all the problems.’

‘I asked Wong Ka Bo that what is user requirement for interaction’.

Observing in relation to questions

‘Unforgettable tutorial: Filling water what is the relation between the interface design and a glass of water???’

Interesting, fill the little paper with a big glass of water with blinded eyes?

What is the aim of this game? That is telling me that we can feel the paper glass

is full or not by the weight, touching, sound, etc. We know how is our activity result according to the feedback, like listening to the water.’

Observing

Data collection

‘Then I realized that our senses are used to receive data, then we could generate some information out, which helped us to make up a decision.’

Comments about noticing things

‘It was the second day of the Joint-U Dancing Society Inter-flow camp. I was the committee of this activity. The other committee and me decided a lot of Mass Game to let the members play. One of the games was called “Across the electric network” which means the members needed to app all the people from one side to the other side but had a bar between two sides. I observed that every group solved the problem by different methods like our first tutorial. Some of them were very cooperative. The helped everyone to pass over it including the last one. But some of them let the last one to jump over the bar by himself/herself.’

'Later we realized computers were tools, it had the above features too. We needed it to solve problems so we created it.'

Filling in the blanks

Connecting different knowledge

'Sometimes you cannot find the solution easily, because the solution is out of your "range", try to sit back and find the solution in another way, like the game in tutorial 3, the tools that you are needed is not near you, but it is present and you are not aware on it!!'

' In this class, we were told to design a page in a magazine. The guidelines, reading materials and pictures were given to us. The task was to choose a picture with relevant paragraph and paste on A4 size paper.

I think the most important technique is to choose relevant information from lots of raw data. When you have lots of ideas in your mind, you should choose those relevant ideas in a group, and drop the irrelevant ideas in your mind. The use the relevant to build up a conceptual model.'

Understanding things not specifically stated

'The interface in the lecture now change a bit, because lecturers give some notes to us. I think this interface is more suitable for us, we want something for us to follow. The feeling is more secure. Therefore I think let the user feel secure in using the programme is important too. Secure come from the surance in knowing how to use the programme and knowing what guidelines to follow when they face problems in using the interface.'

Questioning

Asking own questions

'Observation

'Today I read some websites of Human Computer interface, I discover that most of them like to use yellow and white as background color.

- a. Having 'go main' function is good design for web-page if there is detail information which cover more that 1 page of screen.

Question

- a. Why most web-page use yellow and white background color?
- b. What's colour is good for design?
- c. Do any rule about using colour to design interface.

[two weeks later:]

Own notes

The use of colour is the main value to make the display more interesting for users. We can use colour for highlighting reactions and important field. Assign colour to user expectation is blue for cold, red for hot, green for go and amber for wait. The good high colour contrast for character is white on black, white on blue, and black on blue.'

Thought

Colour is key factor to design interface and so I need to find a set that works in the masterful learner fitting in organisation, and define some standards.'

Question

- a. Is it good to use colour as warning message in masterful learner?
- b. Which is colour good for background for masterful learner: black, blue, or white?'

Talking to friends

'What I talked with my friend after the lesson: Since both of the subject content and the style of lesson are the new try for us, it gave us interesting topic on guessing the relation of the activities and the subject.'

' So I talked to my partner that to find a way how human evolve as there are many types of evolution.'

'Almost every one had borrowed a reference book and is studying them or discussing the content with each other.'

Talking to the lecturer

' Finding Dr Barbara

Because we are confusing in doing the assignment. And some terms that we are still not understanding e.g. what is a conceptual model, what is dialogue, etc. And we prepare a outline of our assignment to let Dr have a look on it.'

Metaskills

Comments about the learning process

' I had borrowed a book called Human Computer Interaction, since the book size is not too big, so I just used one day to read through of it. After reading the book, I found that HCI indeed is an abstraction subject, you can not just listen to the teacher teaching, you also need to involve your creative and researcher mind. At this point, I then found that the confusion mind will not disappeared until you stop to learn Human-Computer Interface, the reason is that once you can understand a very complex question, another much more complex question will occur, this situation will continuous occur and will not stop'

'Learning is not just reading the books. Learning process is relatively slow if we just read books. The process can be catalyze through practice and picture out what we have learnt so that we can "increase" our memory.'

' Through the illustration of this course, several insights have come to my mind.'

Hong Kong Students are Examination Minded

'It is understand that the learning approach in Hong Kong is spoon-feeding and service learning. Students have high expectations on lecturers. Besides, students are eager that lecturers can give the clear and enough information on how to master the course. Really master the course? Well, examination I think.'

Self-Learning is Essential in University Learning

'In my opinion, spoon-feeding approach no longer help learning efficiently in a long-term method. We should notice that no marking schemes would be provided in passing examinations. No perfect model answers, no sure win tips will be provided. Since university study does not aim at testing our memorization ability, our creative thinking, critical abilities are much more important.'

Insights into own learning

'I also learn how to use the raw material to represent ideas. However, it is difficult to use only few things to represent the whole idea. For example, during the tutorial lesson, the user may not know the meaning of the model if without the explanation. The precise explanation is very important for the visualization model.'

'The idea I got from this tutorial is, the user of an interface is just like the one pouring water with eye hindered, don't know anything, don't know how to use the software. He can use this method to try to use, but maybe it's not the best method. The best method is to get the information from the observer, from the instruction of the interface. So, a good interface should provide a way to guide the user to use the software, only give right instruction, no misleading.'

Awareness of thinking process

'In the past I seldom observed the others. This week, I knew that the observation around myself was useful and important. Observations have advantages of being cheap, easily replicated, adaptable and they give many insights into usability. Also, it does give us insights into why people take certain actions, it is relatively cheap and it can be effective'

'This week I'm going to mentally preparing about what HCI is and here is what I learn about HCI:'

Actively making connections

Sudden understandings

‘Through drama on metaphor, we can understand that why there is tools. It is because there is a problem and the tools become the solutions. As human continue to learn, there will be new, better tool development.

Try to solve some problems, like do some calculation, make a cloth holder, to reproduce a magazine, reshape a stone into a star shape, etc. This shows us that when there is a problem need to solve, people will try to find solution. These sequences of actions just like the relationship of action to reaction.’

Pondering how things relate

‘Week 6, 20/3: Travel in MTR, find that there are station names full of the corresponding station wall. It is really useful to passenger. Without these station names, we may not know if we are at the correct station. Even there is announcement from the driver, passenger easy to pay attention on it.

- In design interface, each page should contain enough information to show where the user is at.’

Looking for things to connect own questions

‘Due to I want to know more about why lecturers always want us to extend our media to video. I search the topic on video about video and I found the related information luckily. It mentioned that we have to be particularly careful when we extend our media to video, films and high quality diagrams.’

Evidence of the joy of learning

Self reports

‘ Firstly, I don’t know why we saw the “King-kong” video in the lecture, I just saw a “King-kong” use a stick to break the bone. But after that, I thought deeply that both the human and animal knew to use tools to perform their job efficiently and quickly.’

Sense of excitement in writing

“1. What insight you had & what connections have you made from video & lectures?

- connection?

Make connection between the lectures & the assignment ‘Masterful Learner’

That is why learning = connection too.

Great! ”

‘The learning materials of this week is very funny, I meant the video about monkey. May one felt interested in it. And we searched the topic on video about video and found that the related information on the web.’

'She appreciates me very clever. But I know that I am not clever, I know it because I start to observe things which I am interested in. And this technique I just learnt from HCI. Oh! – very wonderful!.'

Compulsions

Using own time to think

'When I gave a phone call to my friend, as she is not available, I need to leave a voice message to her. This makes me feel uncomfortable as I know that I am speaking to the air. After I leave the message, I really worry that if she will listen to the message or can she fully understand what I want her to know. Interaction is important, when someone has made an action, he will be expected for a reaction. So I think in the project interface design, the application should give a reaction to user action. This lets the user know more about what is happening.'

Learning outside formal context

'I watch TV. When it shows black & white, I turn to TVB. => Colorful things are more attractive.'

'Why is Mr. Chow's film more popular in Hong Kong? Because it is simple. We can understand. => Every interface is better to be simple.'

Returning to questions again and again

'This Saturday, I had a visit to a computer store with my friend, at first I just want to relax and have a general meeting with my friend, however, after the trip I got many useful pieces of knowledge and wonderful ideas about Computer Interface design. For example, I found that we now can design an interface that just requires the user to speak to the computer and then the computer will do all the things for him. As of this finding, I then think if we can design an interface that will do the appropriate action according to the user's general reaction such as emotion. Then, I think the user will be very happy since they can operate the computer system without attending any computer training course.'

'Today, I finished a puzzle and decided to put it into the wall in my bedroom. I used a hammer and a nail to make a hole and a supporter. Therefore, I can put my puzzle on the wall. It made me think through the last tutorial. I used tools again! If I did not have these tools, I thought that I couldn't put my puzzle on the wall.'

'After Chinese New Year, I have taken a week's holiday. During this vacation, I have seen plenty of web-sites about this topic – Human Computer Interface'

Questioning

'Here, we also do not know what is the interaction meaning of the conceptual model. How does the user interact with the conceptual model?????????'

'As time passed, I know to use the 'teamwork' now and I discover that actually 'teamwork' is a very useful tool for us to do the DFD, DD and PS for a system. Then I will think back why we think the 'teamwork' is not useful at all. The answer is that the tool is good, but the interface of the tool is bad.'

Other whole person development skills

Other skills which we have observed in relation to the whole person development apart from the learning skills are:

Self management

Time management and work organisation

'Today I was delayed for the lesson, so I cannot attend the lecture. I then go to the library to find some useful books for the masterful learner assignment. I borrow some books from the library.'

Application

Wanting to make an effort

'Different representation of the same material will give different feeling to the user. If the document is full of text, the user may probably be bored. On the contrary, put some wonderful pictures in the document may get the attention from the user and feel more comfortable. This is a constructive idea to develop the masterful learner. Therefore, I spent all day to browsing the web site and reading books to find out some wonderful pictures.'

Determination

'But I think I may need some time to adapt to this type of learning, as I have not take a course like that. Whatever I would try my best to get the best performance that I can get!'

Handling emotions

Commenting on emotions

' I have attended 2 lectures and 2 tutorials for the 'Human Computer Interface'. Now I want to write down what is my feeling of this module. At the semester break, when I first get the timetable of this semester B, I was very happy that I have to study HCI this module because this module is only gain 2 credit units and I only have to spend 2 hours for this module every week. ---- VERY LOW WORKLOAD & VERY EASY.

[...] However when I finished the initial test for HCI I know this will count as part of my coursework mark. I start to feel nervous. And I ask myself 'What will going on for this module?'

Resolving own emotions related to learning

[See subsection on filling in the blanks in the learning section above – P.86]

' Tutorial 3: Sorry, sick leave!!!!'

'For conceptual model, the concept I got is very vague, fortunately, there was some supplementary notes that I can refer to.'

4.5 Who actually improved

Given that students exposed to the Integron methodology demonstrated overall performance improvements on the exam compared to other student cohorts, we began to ask the question who, specifically, benefited. We were specifically interested in the relative effectiveness of the Integron methodology with students of different ability levels.

To this effect we performed a simple preliminary investigation for a majority of the students participating in the HCI course⁴⁵ using their grade point average from Semester B for the 1997-1998 year and our own calculation of a grade point score for each student based on grades both for the exam and for his/her performance on the course work. For both the exam and the coursework we then calculated the difference between the previous GPA and the HCI course/exam results. This number told us whether a student had done better or worse on the HCI course than his/her average.

Overall, some students improved their performance compared to their previous GPA and others did somewhat more poorly. This comparison indicates that the Integron methodology appears to benefit all students, but not equally. The less able students (as determined by their grade point average) show a disproportionately greater improvement when exposed to the Integron methodology than do students with a higher previous GPA.

To get our comparison, initially, we correlated performance on the HCI course and the HCI exam with the previous GPA. The correlation between coursework performance and the previous GPA was low, coming in at 0.31953542.

The correlation between exam performance and the previous GPA was also low, coming in at 0.33817362.

To see if there were other patterns in the data, we did the second analysis. In this analysis, we broke students on the HCI course into “cohorts” based on their previous performance. These cohorts consisted of “A”, “B”, “C”, and “D-F” students which were calculated based on the GPA of each student. Criteria for parsing the students into each cohort are outlined in Table 23 below.

⁴⁵ Some students did not have a grade point average for the previous year, because they were first year students in the year 1998-99, so they were deleted from this part of the evaluation

“Cohort”	A	B	C	D-F
Grade Point Average Selection Range	≥ 3.5	$\geq 2.5 \ \& \ < 3.5$	$\geq 1.5 \ \& \ < 2.5$	< 1.5
Description of Student	Excellent	Good	Average	Poor

Table 23. Parsing Criteria for Student “Cohort” Based on Grade Point Average

We then looked at performance on the HCI course for students coming from each of these different bands. The results of this comparison are summarized in table 24 below.

“Cohort”	A (Excellent)	B (Good)	C (Average)	D-F (Poor)
Percentage of students improving on HCI Coursework compared to their own GPA	38%	43%	50%	88%
Percentage of students improving on HCI Exam compared to their own GPA	21%	39%	65%	100%

Table 24. Percentage of student improvement

From the Table 24 above it can be clearly seen that many more of the “Poor” students (based on previous performance) showed markedly greater improvement on both coursework and the exam than did excellent students. Many of the excellent students actually showed a decrease in performance. Overall, the lower the student GPA coming into the HCI course, the more likely that student was to demonstrate significant improvements in terms of traditional assessment criteria.

A more thorough investigation of the correlation between GPA results and the effects of the Integron Method is necessary to confirm this initial finding. We believe, however, that, based on this preliminary investigation, it is fair to say that the Integron methodology helps all students to learn better, but it helps poorer students proportionately more than good students.

One reason we believe this happens is that less able students are actively looking for approaches that can help them to improve, so are more open to new approaches. Students with higher overall grades, however, may have been successful in the past because they have been able to “beat the system”, i.e. they have developed strategies that have allowed them to be successful in traditional exam performance. Any new methodology that takes them away from their favored, and previously successful, strategies is likely to meet with some resistance.

During the HCI course we observed a number of students who initially reacted quite negatively to the new teaching methods. We now know that some of these were actually students with previously high GPA's. Some of these students discovered the benefits of the Integron approach and became increasingly excited about what the course had to offer them while others did not get so involved.

As a consequence, it is our contention that the Integron methodology *can* help all students, both poor and excellent alike. The degree to which improvement actually happens, however, depends on the degree of involvement and commitment of each individual student. Whether or not this commitment can be generated, of course, depends to at least some extent on how effective learning facilitators are at implementing the principles of the Integron Methodology.

Section 5

DEVELOPING AN INTEGRON BASED COURSE

"Cheshire Puss," she began, rather timidly, as she did not at all know whether it would like the name: however, it only grinned a little wider. "Come, it's pleased so far," thought Alice, and she went on. "Would you tell me, please, which way I ought to go from here?"

"That depends a deal on where you want to get to," said the Cat.

"I don't much care where -" said Alice.

"Then it doesn't matter which way you go," said the Cat.

"- so long as I get *somewhere*," Alice added as an explanation.

"Oh, you're sure to do that," said the Cat, "if you only walk long enough."

Lewis Carroll

Alice's Adventures in Wonderland

As outlined in earlier sections, the Integron Methodology is unique in the way that it integrates and expands upon methodologies developed for facilitating and accelerating the process of human learning. In 1999 we chose to make use of the HCI course at the City University of Hong Kong for the purpose of testing this approach within the Hong Kong Tertiary Education environment. As indicated above, the initial application of this method generated significant improvements in learning, both of subject matter, and of the meta-skills (cognitive and affective) that are necessary for life long learning.

For initial testing the method was applied to a course that teaches design. However, it can be used in part, or in it's entirety, for the design and delivery of any form of learning, within any context. This includes corporate training, tertiary education, and education throughout primary and high school.

This section is intended to provide guidelines for people who wish to begin working with this methodology to improve their own skills in facilitating the learning of their students.

In this section we outline the *process* by which the Integron Methodology operates in terms of the selection and application of appropriate teaching tools and practice. In developing and applying the Integron Methodology there are, in essence, four main steps:

- Identifying core objectives
- Mapping out the course
- Structuring the grading system
- Lesson by lesson design

We discuss each of these major steps in detail below.

5.1 Identifying core objectives

In it's essence, the Integron Methodology is very strategic. By this we mean that the learning facilitator must first have in mind specific goals that are to be achieved in the learning process. Once these goals have been determined, the design of the course follows naturally.

In our view, the primary step in designing a course using the Integron Methodology is the determination of the learner transformations that are required if the course is to be successful. In setting the transformation goals one must generally consider:

- The starting state of the learners
- The final state the learners will be in at the end of the course, and
- Evidence of satisfaction conditions

It is important to realize that the work done to describe the starting state of a group of learners should be open to revision in the face of evidence obtained from interacting with the learners once a course has started. The initial definition of starting states is more about framing a set of working hypotheses rather than locking the starting state in stone.

As an example of goal setting, in the case of the HCI course in 1998-99 we initially spent up to a week of solid work establishing our goals. We actively avoided talking about specific teaching materials or techniques, although we did record interesting ideas that came to us naturally at that stage. Given our focus on the learning process, the first order of consideration was how we wanted our students to change as a result of participating in the HCI course.

5. 1. 1 The starting state

The first step in goal definition involves describing the starting state of the learners. This description involves a number of elements, including:

- Expected current levels of learner knowledge vis-à-vis the course content
- Likely background of the learners, including the sorts of things that are likely to be already grounded in the learner's experience
- Key concepts that the learners most likely have not yet grounded in their experience
- The type of learning that the group would be most accustomed to
- Emotional and affective orientation toward the subject and material to be learned
- Meta-cognitive skills that the learners have most likely mastered
- Meta-cognitive skills that the learners most likely have problems with
- The presence, or absence, of effective learning strategies
- Likely levels of self esteem

In our case, for the 1998-99 HCI student cohort, we initially drafted a description, making it as accurate as possible, of what we believed would be the starting state of the group of learners who would be participating in the course. To do this we relied on a number of sources of information. These included experience with City University Student Cohorts from previous years (Barbara Gorayska), the comments of staff members responsible for teaching the target group of students during the first semester of the 1998-99 study year, and experience with young adult learners in Hong Kong (Chris Lonsdale).

5. 1. 2 The transformed state

Once the initial learner state has been described as accurately as possible, you must then begin describing the ideal state you are hoping to achieve through learner transformation. This end state can consist of many different elements, including:

- a) Cognitive skills specifically relevant to the discipline being taught
- b) Attitudes that support mastery of the subject or discipline being taught
- c) Knowledge of specific fact clusters that support an understanding of the subject
- d) Critical mental models underlying mastery of the subject
- e) Language labels that support understanding of the discipline being taught

- f) Emotional mastery for the context of the discipline, or a wider set of contexts (if appropriate)
- g) Meta-cognitive skills useful both for the discipline being studied, and a wider range of disciplines

5. 1. 3 Nesting goals

An important concept that needs to be addressed when deciding on goals for transformation is that these goals can, and often should be, nested. By nesting we mean that some goals are very specific to a particular course of study, whereas others are more global (meta) in nature. In general, meta level goals provide the substrate upon which more specific goals can be built and, therefore, in the course of designing a program of study these meta goals need to be considered ahead of the more specific goals that are only course related.

For example, mastering effective learning strategies is a meta-cognitive goal that will influence all elements of an individual's learning. Self esteem is a meta-level affect goal that will influence motivation, participation, uptake and a number of factors that will also influence learning on a more general level.

On the other hand, the ability to use metaphors, for instance, is more specific to a design process, and does not necessarily have effects that are so wide ranging on other disciplines and areas of study.

5. 1. 4 Transformation Goals for the HCI Course in 1998-99 – our example

As an example of how the identification of starting and ending state can assist in defining learner transformations, in this section we describe the transformations that we decided upon for the 1998-99 HCI student cohort.

Based on our examination of starting state and transformed state for the year 2 computer science students enrolled in the HCI course, we decided that this group of students needed to go through a range of different changes.

- **Extrinsic motivation to intrinsic motivation**

First, we wanted the learners to switch from being extrinsically motivated (by their parents, by the society with its employment and status structures, or by the university especially in terms of the assessment procedures) to being intrinsically motivated and wanting to learn in order to improve themselves. We wanted our students to become life long learners, that is, to develop into individuals who are curious, interested, inquisitive, and committed to both discovering knowledge and self progress. We wanted them to increase their self esteem and to appreciate being at the university.

In the overall scheme of the course, this was seen as a meta-level goal. Not only would achieving this goal support student mastery on the HCI course itself, it would provide the students with resources to master other courses more easily and to be more effective when joining the work force.

- **Move from receptive information intake to proactive knowledge construction**

We established that at the outset a majority of the students were most likely eager to learn but had few practical skills to do this effectively. They tended to avoid failure and were predominantly exam oriented. Their metaphor for learning was more similar to that of a tape recorder than that of growing trees i.e. an organic process of continual growth and embellishment.

The students were perceived by members of staff who had taught them as being mostly passive and receptive, as well as being weak in common sense reasoning, observation, and integrating knowledge across domains. Based on our past experience of teaching HCI to computer science students, we had fair grounds to believe that many of these students would probably be weak in abstracting general principles from specific cases, handling theoretical material, and turning factual knowledge into corresponding practical applications. We expected their English skills to be relatively poor as many of them had entered the university with scores at a lower end of the GCSE scale in this subject.

Given the above characteristics, we intended for the students on the HCI course to develop a goal seeking approach to learning, to see learning as a process and an adventure, to seek knowledge independently and take responsibility for their own progress. They were to learn to see “failure” as feedback and an opportunity for self improvement.

As with the first major transformational goal, we also perceived this goal as being a meta-goal, in that achieving it would establish the conditions for the students on the course to more easily achieve the learning goals both for the HCI course, and for other courses in which they were enrolled.

- **System oriented view to user oriented view of interface**

Majoring in computer science, the students had studied *software* engineering and database design, and had learned several programming languages. In this course they had to develop new mental tools specifically appropriate to *human* interface design. This meant they had to fundamentally change their approach to developing computer applications, moving away from the system centered perspective towards a user centered perspective.

In practical terms the students had to learn to see system functions as extensions of users' tasks and the applications as tools that extend people and diminish human limits. They had to learn how to communicate the use of these functions in ways that people, and not computers, would understand. In order to do this correctly, they had to develop a totally different mode of thinking, switching from the convergence of programming to the divergence of the multi-modal, predominantly visual, user interfaces.

- **Developing artistic and creative skills**

In order to acquire the practical designer skills our students had to become imaginative, creative, open-minded and artistic (do a lot of sketching). In particular, they had to learn to observe people, elicit relevant information from 1) a variety of testing methods that involved human subjects and 2) from human-to-human interviews. They had to learn to proactively communicate with people, formulate questions, negotiate their points of view, report on their own individual experience, and develop a team spirit.

What we really intended our students to be able to do at the end of the course was to deal with any new task (including tasks of designing interfaces) effectively, efficiently, with confidence and in a professional manner, irrespective of circumstances. In other words, we wanted our students to become well integrated emotionally, socially, intellectually, and professionally.

5. 1. 5 Evidence as satisfaction conditions: how one knows that students have learned

In the design of an effective learning intervention one must have appropriate feedback. In order to determine the satisfaction conditions for learner transformation goals at the start of a course it is important to ask how you would know that, or when, learners have indeed been transformed. That is, you need a set of objective evaluation criteria by which to assess student behavioral outputs, and map these to the internal transformations that you are trying to achieve.

Objective evaluation criteria

Setting up such evidence criteria at the outset is important as they become the driving force for designing and/or modifying the activities, class rooms and presentations for the course.

Knowing the type of evidence one is looking for helps design methods of assessment.

- Evidence for whole person development

For instance, in our course we felt that whole person development could best be monitored through diaries or daily logs, while the knowledge of course materials and content could be evaluated on the basis of the answers to more formal examination questions.

In our particular case we had to monitor how the students developed as whole persons, how they increased their creativity, how they learned, and which specific HCI skills and knowledge they were acquiring.

- Evidence for learning of course content

We used a number of different methods to observe and monitor students' progress. Student knowledge of HCI and the designer's skills were evaluated on the basis of the answers to more formal examination questions, and the interface design project that students were given as part of their course work.

- Evidence for engagement and motivation

Towards other goals was measured in a number of different ways. For instance, in small group interactions (Tutorials), we observed levels of participation, self management, creative leaps, group creative process, interpersonal communication, observation skills, and emotional responses to activities and course content.⁴⁶ This was done both “live” and, on occasion, with subsequent viewing of student’s video-taped responses to the techniques we used.

Curiosity was revealed in the way learners asked questions, discussed things with colleagues, observed in relation to questions, or derived new questions from the old ones. Intrinsic motivation showed up in learning outside the formal context, returning to questions again and again, spontaneous visits to the library, using their own leisure time to think about the subject, and so on.

- Evidence about internal transformations

We also made use of materials produced by students, including any comments they made on their own progress. For coursework we set a daily diary task. As with many elements of the Integron Methodology, this in itself was multi-purpose in nature. It afforded reflection by students, provided a mechanism for grading specific behaviors (such as observation), provided a mechanism for us to give feedback to the students, and allowed us to collect data about student responses to the learning process.

In addition to the diaries, we also used a number of other methods to tap into the students’ overall internal state changes. For instance, on two occasions we made use of a questionnaire to judge both their emotional reactions to the course, and their mental maps of what they were learning. On other occasions we used a paper based “lottery” question and answer session to surface questions and problems that the students were struggling with⁴⁷.

⁴⁶ Emotional changes and responses can be observed from subtle changes in body language. This area has been widely researched and applied within the field of NLP.

⁴⁷ This technique involved getting students to write questions and concerns on a piece of paper, and then put it in a box. We then picked papers from the box randomly and answered the questions thereon for the whole class. Questions not answered verbally in this way were subsequently answered in writing and posted as an e-mail to all students. In this way we maintained a two-way communication and feedback process.

Based on data collected through these different observational processes we were able to make reasoned judgements concerning the internal life of the students, and the level of skill mastery. For example, the evidence of how well the students observed things showed up in the ways they collected data, noticed things, or in comments of surprise. For instance, in the first small group interaction students were essentially unable to observe with any great deal of accuracy. They were, in essence, blind to various elements of an exercise that we gave them. And, they were almost unwilling to observe what was going on, preferring to be spoon fed by the learning facilitator. Later on in the course, however, the same students would observe an exercise with a great deal more focus and would notice very subtle details that they would then be able to report to the class as a whole, or to their own small debriefing group.

Similarly, meta-cognitive skills were demonstrated by spontaneous comments about the learning process, insights about students own learning, awareness of the thinking process, realization that learning does not stop, etc.

We anticipated that creative mental activity would be demonstrated by how the students made new connections, in the self stated insights, in volunteered ideas not taught in the lectures, or in linking the HCI material to other courses. And we expected that creativity would also be evident in students' drawings, skits, and group discussions.

Specific HCI skills concerned visualization, questioning, testing interfaces with real people, using metaphors for design, presentation of documentation material, etc. We expected deeper understanding of this knowledge to be demonstrated by students a) in providing own examples for the new key terms introduced or b) in showing awareness of how specific dialogues worked by selecting appropriate objects for users to interact with that supported users' specific tasks.

Relevant affective responses to the techniques we used would involve enjoyment of music or games, a sense of learning and excitement, comparisons between the students' own learning experience at school and in the HCI class.

We also monitored ways in which the students broke away from the traditional educational types of responses, for example, coming to see the teacher in person or quotes of discussions with other students. We also expected the students who deep-learned to embed in their reports, as their own discovery, the material taught in class or to comment on their own behavior in a way that matched metaphors and stories presented in class.

5. 2 Mapping out the course

Once the transformational goals have been established one must finally get down to actually designing the course. This involves an interactive process, starting with a large scale overview, and then progressively working down towards lesson-by-lesson detail. In mapping out the course, a number of issues need to be considered, namely: prerequisites and sequencing, themes for repetition and reinforcement, conscious and unconscious messages, communication loops, external resource constraints, metaphors and possible holographic units.

5. 2. 1 Sequencing and pre-requisites

In course design, even though one attempts to create a series of holistic, integrated experiences, this still has to be done within the linear constraint that is imposed by the nature of time. In other words, you can't do everything at once, so you must choose an order in which to communicate with learners. Within the Integron Methodology this choice involves thinking about sequencing and prerequisites at two very different levels.

- **Ordering of conscious elements**

Firstly, you must consider the order in which particular concepts and experiences should be arranged for conscious consideration by learners. Addressing elements at the conscious level is the most linear part of the whole course design. It is useful for learners to master (or at least be exposed to) certain basic skills, ideas, etc. before being exposed to others. Elements provided early on in a course must provide a foundation for subsequent learning developments.

So, for instance, in the case of the HCI course, we decided it was necessary for students to first experience interfaces from the point of view of a frustrated user before getting into the development of their own interface. We decided that the appreciation of the computer as a tool that helps people perform tasks is important for appropriate consideration of design principles, so this needed to be addressed ahead of the steps in a design process. And, we decided it was necessary for students in the class to be exposed

to their own creative success early on, as this would provide a foundation for creating effectively throughout the course.

- **Ordering of peripheral elements**

The order in which conscious elements are presented in a course provides a skeleton that keeps the learners' conscious mind actively employed. Beyond this, it is possible to introduce a rich complex of "data" into the learning environment. This "data" can encompass all of the major themes and points of a course (including meta-level communications), and is intended to be processed peripherally and initially at an unconscious level by the learners.

Presenting information in the environment at an unconscious level before it is discussed consciously primes the learner and makes it seem familiar when the time comes to work with it at a conscious level.

As with conscious level information there are some limits as to how much material can be layered within any given learning interaction, so choices have to be made about sequencing and ordering of these peripheral learning materials.

In the case of the HCI course we designed every interaction with the learners in a way that included multiple levels of communication that were often not discussed at a conscious level. For instance, using Brain Gym in the first tutorial communicated to students about the integration of mind and body, though no explanation was given as to why we were doing the exercises. An exercise pouring water blindfolded into a cup communicated about feedback, about interaction (e.g. between a user and a computer system) and about observation. At the time of the exercise only some of these elements were discussed at a conscious level. Other elements were left undiscussed, but were communicated both from having been present, and through the attitude maintained by the learning facilitators.

- **Themes to be repeated and reinforced**

Certain elements of a course of study are of greater importance than others in terms of critical transformations required of learners. These themes can be built into the fabric of a course from the beginning to the end and can show up under different guises. Important elements should be repeated from a number of different angles throughout a course developed using the Integron approach.

So, for instance, taking on a user perspective is a critical skill for interface designers. Hence, in our course, we continually re-addressed this theme from a number of different perspectives. Students got to experience lectures and tutorials as interfaces, and were asked to notice their own reactions to these contexts. They were asked to work with a particular piece of software, and notice their responses to it as a user. They sat an exam on the first day of the course, and were then given feedback that they mostly failed because of a clear lack of concern for the user.

- **Communication loops**

Meta-level messages can be used to create bounded contexts for the learning process as a whole. This is done by deciding on certain messages that are then communicated at the beginning of a “phase” of learning, and then again at the end. Material that falls within the boundaries of these two communications then tends to be integrated at an unconscious level.⁴⁸

In our HCI course we looped a number of things, including stories, exercises, assignments, and even feedback from the students to us. In our experience, each return to a loop helped to reinforce the content of the loop, as well as the relationship with the course content as a whole and this helped in the overall integration of both the course material and the meta messages that were being communicated.

- **External resource constraints**

External resources available at the time when a course is delivered have a bearing on the choice of effective activities that can and will actually be implemented and executed. By constraints in the teaching set ups we mean those factors that cannot be altered or eliminated. Resources are the materials, technologies, and spaces etc. that one can make use of in delivering the material to be taught.

⁴⁸ This method of looping has been discussed in the context of looping metaphors by Joseph O’Connor and John Seymour in their book *Training with NLP*. Harper Collins (1994).

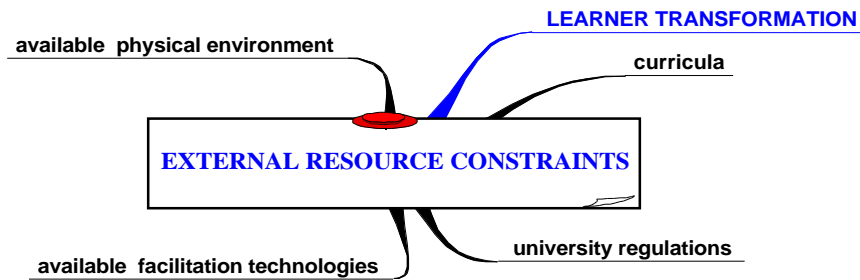


Figure 24. External resource constraints in an Integron

Resources include synchronized facilitation technologies such as web sites, presentation tools such as PowerPoint, networking facilities, projection gadgets, etc. Which specific technologies will be used depends on the technical support for the course, the speeds with which materials can be produced in real time, or how fast changes can be made to the material already in place should the students develop slower or faster than originally anticipated.

Another form of resource is the physical environment in which the course activities take place, e.g., the layouts and fixtures in lecture rooms, classroom size or the seating arrangements, all of which afford some activities and inhibit others. A good example of an inhibitory environmental resource, mentioned earlier (Pp. 22-23) is the design of the City University teaching studios.

University regulations and program curricula also pose resource constraints. For example, the amount of coursework and any other related activities students can be expected to do during the course depends on how many credit units they can earn in that course and on how many other concurrent courses they are taking. Further, students can only be officially examined during the university examination time. The examinations have to comply with the accepted university standards. The taught material has to satisfy the officially specified aims and objectives, and so on. All these factors can have a negative and limiting bearing on the activities and student effort expended.

In our pilot study the students reported that they would have done more work for the HCI course had they been able to gain three and not two credit units. Some students openly requested us to make the change and when the request was not granted some of them dropped out towards the end of the course due to the heavy workload for other concurrent courses for which more credit units could be scored.

- **Metaphors and holographic units of communication**

In line with the principle of doing what you want your students to learn, it is important that, wherever possible, a course is designed according to the principles being taught. In other words, in designing a course it is important to realize that it has the potential to become its own metaphor.

In preparing and delivering the course material for the HCI course we adopted an interface designer's thinking process: the design of the course itself was to be a high level metaphor for the topic being taught. Exposing students to the metaphor would help them explore new ways of thinking about the process of design.

Organizing the course activities and the learning environment was analogous to designing usable interfaces. We started with establishing the real need these particular students had for learning. Based on this understanding, we specified which of our tasks and their tasks would satisfy the needs identified. We monitored the execution of the tasks during the course. We interpreted the outputs against the expected outcomes and our initial intentions and we modified the remaining part of the course material when the expected outcomes fell way outside of the intentions and the goals.

This was very much the process that an interface designer must use when designing a computer interface.

5.2.2 Using a flow chart

In designing the overview of a course we found it very useful to make use of a flow charting approach. This helped us map out what key elements would be addressed at a conscious level initially, and where we could build in critical unspoken elements.

Multi-layered peripheral communications were not built into the flowchart as it served merely as an overview. These sorts of communications were, however, designed into the course on a lesson by lesson basis.

The flow chart (Figure 25) that we developed for our initial plan for the course can be found on the next page. This flow chart was our first iteration. It did, in fact, change somewhat during the development and delivery of the course, so the final course flow was a little different to what is shown here. However, the main elements and issues

addressed, and the sequence in which they were addressed, mostly follows what is outlined here.

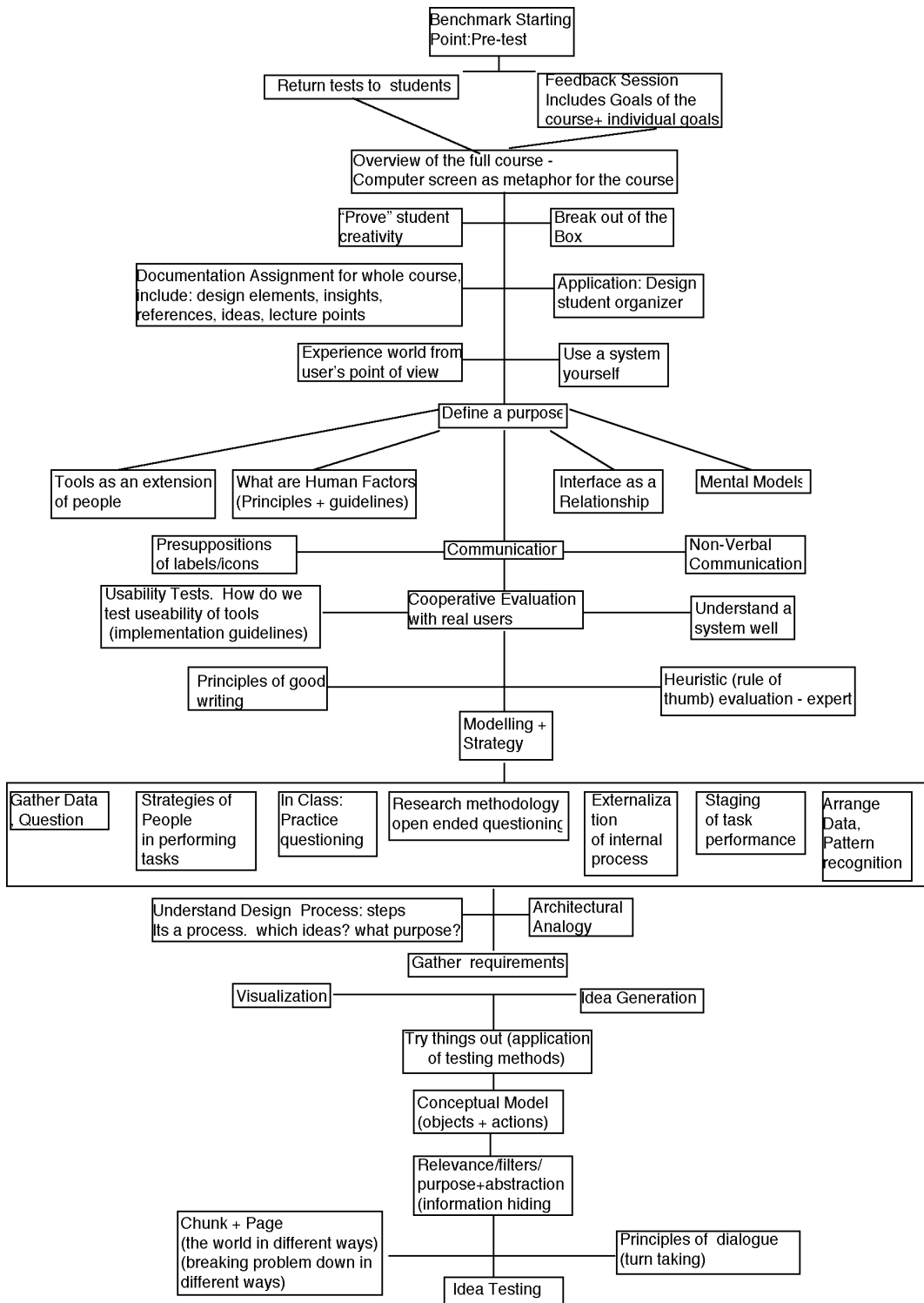


Figure 25. Flowchart of HCI Course Design – First Iteration

5.3 Structuring the grading system

Students of a University course face a major resource constraint – namely the time they have available to produce outputs on all of the courses that they are attending. As a consequence, they very quickly decide the minimum requirement for each course in order to obtain good grades. Sadly, for most courses this simply involves getting a copy of the notes and committing these to memory for regurgitation at exam time.

This behaviour is, of course, a natural response of the human organism. The more experienced we become the more we look for the simplest and most direct ways of achieving our desired outcomes. In other words, more money for less work is a desired goal of most mature adults.

Given that a learning facilitator has the goal of helping learners master both course materials and meta-level skills the development of motivation in the learners to tackle these issues is of paramount importance. Naturally, longer term it is desirable for learners to generate their own intrinsic motivation for a course of learning. However, given historical factors, initially it is the responsibility of the learning facilitator to generate motivation in the learners.

The easiest way of establishing initial motivation levels in learners is to provide extrinsic rewards for behaviours that will lead to the learners attaining critical skills and affects. Within a university context, grades given for performance on courses provides the initial and necessary extrinsic motivation.

In designing a grading system it is important to decide upon which particular outputs from students both indicate internal transformation, and provide foundations for future transformations. So, for instance, if one decides that a habit of observing events in the surrounding environment is conducive to deep learning, one would want to evaluate and reward the degree to which a learner does, in fact, observe his/her environment.

In deciding upon how to grade and reward student learning, the following criteria need to be kept in mind:

- The elements to be graded should be externally observable

- You should reward process and activity (e.g. task engagement) as much as, or more than, outputs⁴⁹
- You should reward attainment of foundation skills that lead naturally to higher order attainment
- You should be very specific about what you believe is required for success in the discipline being taught, and reward those elements when they are present
- You should clearly and unconditionally communicate what will be rewarded in a course

In the HCI course we very much followed these guidelines in developing our grading criteria for the course. We required students to make daily observations, to think about what they were learning, to generate their own insights and questions, etc. We took the view that when students were fully engaged in activities of this sort they would naturally learn more and faster than if we simply rewarded them for recall in an examination context.

5.4 Lesson-by-lesson design

When one has mapped out the desired learner transformations and the high level overview of a course one must ultimately get down to designing the course in detail. In designing at this level of detail it is useful to view a course as a series of learning interactions. Some of these involve interaction between the learning facilitator and the learners directly, and some involve tasks which the learners must attempt to complete on their own.

Every interaction that is built into the course has a purpose, or multiple purposes, that relate back to the core goals and objectives for the course. And, every interaction fits somewhere in the flowchart for the overall development of the course.

As a matter of discipline, the method that we have found most useful for designing each interaction involves the following steps:

- Decide upon objectives specific to the interaction being designed

⁴⁹ Often just getting a learner to actively engage in some activity is enough to start the learning process. Therefore rewarding engagement is as important as rewarding the outputs of that engagement.

In deciding upon objectives for each interaction it is useful to break them down into different areas. In our own planning process we created objectives for learner affects, learner behaviors, learner attitudes, meta-cognitive skills, etc. Not every interaction addressed objectives in all of these areas, however more than three different objectives were always addressed in each interaction.

- List key messages and concepts that need to be addressed, both at the conscious and peripheral levels

As a subset of listing key objectives it is useful to think about any key messages or concepts that need to be communicated in order to generate a transformation of some sort in the learners.

- Creatively brainstorm a range of tasks, exercises, stories, visual images, etc. that can possibly be used to communicate key messages and concepts

For example, in our small group interaction designed to teach about tools we had an objective of broadening students' perception of an environment and the opportunities offered by that environment. In that interaction we decided to place semi-useful tools on a table in the corner of the room. The tools could, at a pinch, be used by the students to complete the tasks that they had been given.

The message that we most wanted to communicate through this structure in the learning environment was that often resources are available, but you have to look for them and actively search them out. This, of course, was a meta-communication related to student learning habits, including the required habit of using the library, colleagues, the environment in which they found themselves, etc.

- Select those elements that most readily lend themselves to layering and looping

Once you have a list of different elements that can be included in an interaction, it is useful to prioritize these based on the degree to which each element lends itself to layering and looping. By layering we mean the number of potential messages that can be carried by a particular learning element.

For instance, showing a bullet point slide about the power of labels really only communicates on one level. Elements of this nature would be given a low priority.

On the other hand, “wet paint” signs roping off the top end of a lecture theatre has multiple impacts. This, in fact, is a learning element that we included in one of our large group interactions (lectures) because of the layering that it afforded. In designing this element into a large group interaction we were aware of the many possibilities it offered for communicating on multiple levels.

For one, it creates surprise in what is a very “normal” and extremely boring environment. It generates a reaction in learners who are entering the lecture theatre, and observation data as some learners observe the reactions of others. It communicates that breaking “rules” can generate interesting results. It demonstrates the power of labels and how these often override direct sensory input. It also forces students to move to the front of the lecture theatre, thus changing the interaction dynamic between students and lecturers, while at the same time modifying the spatial perspective of the learner.

And, it requires no explanation. It can simply be placed in the environment and left for learners to observe and draw their own conclusions. Thus, it communicates many powerful messages at many levels with a minimal time penalty. And, due to its surprising nature, it becomes easily fixed into long term memory of the learner.

This particular element is, in fact, an example of an Integron within the larger Integron of a 50 minute lecture style interaction and nicely demonstrates the principle of the Integron Methodology in action.

- Build different elements into a sequence

Once you have decided on the elements that you wish to include in a particular interaction it is time to sequence these (where sequencing is necessary) into the time that you have available.

- Build and prepare necessary props

With the Integron Methodology certain elements often require the development of props for the environment in which you will be working. Once you know what messages you need to communicate, and have an idea of the elements you need in order to do this effectively in an integrated, layered and holistic way, you will need to decide upon the props that you will use in bringing your learning elements into reality.

The things you can consider as part of your “palette” include the space in which you will be working, the way in which you will seat learners in relation to each other and yourself, any tools you might need, multi-media presentation possibilities, etc.

Then, when all of this is done, you have to run the class.

5.5 A word on tasking

Within the Integron Methodology there is very clear awareness that for learners to succeed in mastering both the course content and the meta skills it is necessary for them to become actively engaged in a range of different tasks. Tasks can be designed to occur in the time available for a lecture or tutorial, or to be completed by students in their own time.

When designing tasks it is important to bear the following principles in mind:

- The learner should be able to gain insight simply as a consequence of engaging in the task, not from achieving a specified outcome
- The task should, as much as possible, be multi-sensory thus contributing to “locking in” of long term memory
- The task should afford full, non-self-conscious participation of the learner
- The task should have some metaphorical link to key course messages
- Wherever possible the task should embed unspoken and undiscussed elements that, nevertheless, also communicate key messages related to the task.

For example, in order to help the learners understand the source of difficulties in designing meaningful user-application dialogues, we engaged the class in a silent dialogue game. Small groups of learners prepared in advance some questions and answers on sheets of paper to converse on a given theme. During conversations they were not allowed to add any further queries and responses and had to use only the prepared resources. The participants soon realized, without us having to explain anything, what the real problem of designing dialogues out of context was and were subsequently able to accurately transfer their insights to the domain of the HCI.

5.6 The learning facilitator's challenges

The Integron Methodology provides great enjoyment to the facilitator both in its conception, design, and implementation. And, clearly, it can lead to good learning outcomes. Nevertheless, it provides many challenges to the learning facilitator.

The greatest challenge is probably the amount of work required to design and implement a course using this approach. For the first run of a course using this methodology you must be prepared for a total redesign of most course elements. The core outcomes you want may well be similar to what you have done in previous years. However, the way in which you achieve these will be very different.

A second challenge, as indicated about in our discussion of resource constraints, is the necessity of fitting in with physical and temporal structures designed for a traditional form of pedagogy. You will discover, as we did, that it is somewhat difficult to design interesting, interactive tasks for use with 100 plus students in a lecture theatre context. Not that it is impossible, as we did achieve this on a number of occasions.

Our biggest challenge, in fact, was completing a meaningful, nested interaction within a 50 minute time slot. More often than not we failed, and several times we ran over time significantly.

The third challenge for the learning facilitator is that self examination is critical. A major factor in the success of a learning interaction is the relationship between the learning facilitator and the learners, not just at the conscious level but also at the unconscious level. Outcomes of each interaction are a function of both the learners, the environment, and the facilitator. When you are not getting outcomes that are heading in your desired direction, you must always look to how your own behavior and attitudes may be affecting the outcomes.

The final challenge is to realize that, although you may wish it to be different, you can't actually control anything in your classroom. As a wise man once said, if you kick a ball you can pretty much use physics to predict where it will finally stop. The same cannot be said when you kick a dog...

So, in designing a course to help people learn, you are really putting energy into their system. You can influence how that energy moves, but you can't control the final outcome.

Section 6

CONCLUDING REMARKS

“Real life example:

After the lecture, I get what is learning and the learning method. I really try the learning methods mentioned by the lecturers to learn how to write JAVA program. At first, it is very difficult for me to change my learning habit but as time goes by I get used to it and it really speeds up my learning and increases incentive to learn.”

Ng Ho Yin

The Integron Methodology presented in this report emerged from our attempt to accelerate the learning process in a cohort of second year undergraduates of a Computer Science program when they came to study how to design interfaces to computer systems.

The success of the Integron Methodology arises from the way that it:

- Uses a strategic focus on the learning process itself, and
- Activates the natural learning potential inherent in people

In testing the methodology we were able to achieve the following outcomes:

- In final year exams, students exposed to the Integron methodology performed significantly better than students from previous years. This increase came despite a one-third decrease in teacher contact time.
- Using a pre and post-test method of comparison, 15 percent of the students exposed to the Integron Teaching Methodology were able to demonstrate a significant qualitative shift in their thinking orientation towards the HCI course material. This

contrasted with only a 3 percent shift in the Linguist group taught HCI using the methodology from previous years.

In addition, qualitative evidence collected strongly suggests that there was a significant change in mind-set in many of the students that can be fairly described as whole person development.

These results are more pronounced when they are seen in the context in which they were achieved.

Firstly, the course in HCI that was the testing ground for our investigation allowed only twenty eight formal contact hours in total and was worth fewer credit units than other courses the learners were concurrently taking. This factor alone had the potential to significantly lower the amount of effort the learner would expend on the HCI course, especially towards the end of the semester. This did happen to some degree, though due to the variety and interest generated within the Integron Methodology, many students maintained their level of effort until the last lecture on the course.

Second, being adaptive to the emerging learner needs at the time of running the course (as the Integron Teaching demands) is labor intensive and needs to be supported by flexible physical environments that lend themselves to sensory enrichment. In this respect our resources were very limited. This shows that, with effort and creativity, even fairly fixed contexts can be turned into productive learning environments.

It must be remembered that, from the beginning, this was a pilot study aimed at exploring whether or not accelerated learning approaches and learning environment modification could contribute to helping tertiary students in Hong Kong learn better. Our initial investigation did not extend to include rigorously controlled experiments that would allow us to provide more conclusive evidence with respect to the impact of specific, individual environmental factors and technologies on accelerating integrative learning.

The study does show that, if tertiary institutions begin applying various accelerated learning approaches now available, improvements in learning in Hong Kong can be achieved.

More important, perhaps, than the results we have achieved is the wide range of questions that have emerged in the process of developing and running this course. These questions are of a broad empirical interest and relate to the pragmatics of learning. Questions still

to be answered, for instance, include: Which combinations of environmental conditions are most effective in triggering, facilitating and accelerating restructuring and integration of the learner's mindsets? How can we design learning contexts in educational institutions, including the tertiary level institutions, that utilize the natural ways in which people assimilate to their habitats?



Figure 26. Life with no tools: solving an impossible task

And, there is of course the question of the relationship between student perceptions of learning and actual learning. Students rated their satisfaction on the course very differently to what would have been expected based on their clearly high levels of participation and commitment. And, their qualitative ratings showed a difference to their quantitative ratings. This “disconnect” needs to be investigated in much greater depth.

To us, however, one of the most interesting and important questions is about the nature of giftedness. What has become clearly evident in this study is that a) all learners are creative and gifted when they fully participate in the activities around them and b) all learners fully participate in the activities around them when the *whole* learning environment affords, supports and enriches their mental and physical effort.

The key for anyone charged with helping others to learn, therefore, is to both understand and apply those techniques and create those environments that fully afford, support and enrich the mental and physical effort of learners.

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Appendix Data Distributions

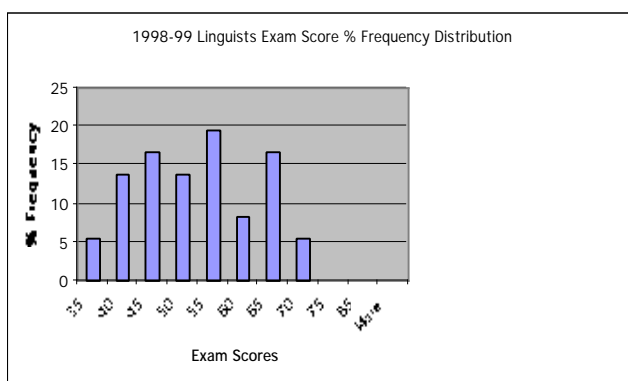


Figure 23. 1998-99 Linguists Exam Score % Frequency Distribution

As can be seen in figure 23 above, data for the linguist group indicated a clear tendency towards being bimodal, with a peak around the B grade area, and another peak around the C grade area.

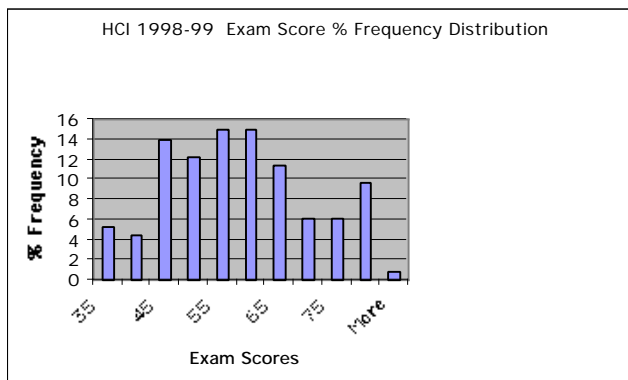


Figure 24. HCI 1998-99 Exam Score % Frequency Distribution

As can be seen in figure 24, the distribution of exam scores for the 1998-99 HCI cohort was clearly bi-modal, showing a clear second peak for A's in the distribution. A peak at the low end of the distribution was also evident.

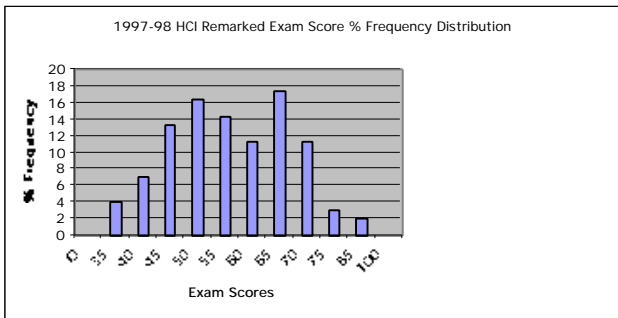


Figure 25. 1997-98 HCI Remarkd Exam Score % Frequency Distribution

While the official exam score for the 1997-98 HCI cohort showed a normal distribution, the exam score based on two remarked questions also showed a tendency towards being bimodal, with a trough around the 65 mark, and peaks on either side (see Fig. 25).

Given that the assumption of normality in the data most likely does not hold, it was necessary to use a non-parametric statistical test in order to evaluate the statistical significance of differences observed between the different groups. We chose to make use of the χ^2 (Chi Squared) Test for Independence to determine whether differences observed between the different groups were statistically significant.

For the purpose of comparing results between groups, we made use of the Computer Science Department standard for assigning grades under the Credit Unit system, and placed students in one of the five different grade bins based on their numerical exam results.

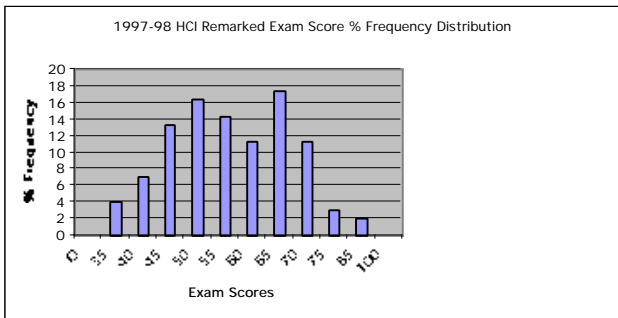


Figure 25. 1997-98 HCI Remarkd Exam Score % Frequency Distribution

While the official exam score for the 1997-98 HCI cohort showed a normal distribution, the exam score based on two remarked questions also showed a tendency towards being bimodal, with a trough around the 65 mark, and peaks on either side (see Fig. 25).

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Appendix 2

Example of Unsolicited Student Comments on the Course

Part 4: My feelings

4.1 Looking backward...

Times goes quickly, the HCI course will finish soon. Looking back I discover that I've improved a lot about HCI. It's difficult to tell what totally new things I have learnt, 1 by 1, but rather, I'd say my way of thinking, observing and learning is changed.

Actually, this course is quite different to what I expect a semester before. I didn't though that this course is so open and requires that much thinking. At that time, I thought that "Interface course" is about "how to arrange dialog, buttons and windows so that user will use it comfortably". Also I haven't though that there will be so much work (including discussion, evaluation and thinking) for a 2-credit course! But this unusual course also make me have unusual improvement.

At the start of semester, I'm not quite understand why my design in initial test get a 'Feedback' grade. I though so because the design is very much like the so-called advanced software we see today. It uses window and mouse that people think that it's easy to use. (Yes, mouse offer better control to keyboards..)

However, when looking at the design now, I discover why the test have such a result. It's because when designing, I **mistakenly** set the focus to the "**technology**" and "**appearance**" (which many people think that it's equal to "interface"), **instead of the user's real need**. I forgot the fact that: what user need is "*a tool that help student to study*" but not "*a set of windows and buttons*". Now, I'd comment my initial design as

“using a pretty wrapping paper to wrap an empty box and give it to someone as birthday present”. Because of heavy workload of different courses, I still have no time to re-try that problem. But I’m sure when I re-do it next time, I’ll have a much better design.

4.2 Why HCI Difficult?

- HCI is an abstract topic and the design process involves many human factor, which we’re not familiar. (We may conclude that “different people have different viewpoint” and forget to find a solution that most people will agree with)
- When designing, we usually place the focus to technology first. I think it’s because many courses we take before are “technical” courses, so we always think of “the technology we have” and then “what can I do in this technology”. Instead of “what I really need” and then “what technology can achieve this”. The former philosophy is more “realistic” because in real world, we always have limited resources such as time and money. But this “realistic” view limits our creativity and discourage the understanding of real problems.
- Well, I’d say “difference in philosophy and background”. Actually I think Hong Kong students are quite lazy to think, because there’re not much courses that requires deep and independent thinking. And I’d say we’re not used to the style of teaching too, In the eyes of students, they think that it’s quite stupid to do exercise in tutorial (although many will SAY they enjoy it, feeling relax) Also, up to now, many, including me, are not used to being “supervised” by video camera.
- Relatively weak to link up different ideas and to relate knowledge to reality. Before studying this course, when thinking of “computer interface”, I only think of “windows”, “buttons”, “mouse” .. etc. But I haven’t thought of “water tap”, “light switches”, “metaphors”. So, we’ll usually ignore some philosophy behind the design of various “interface” and cannot apply the same principle to our design

➤ Misconception about interface. Before studying this course, I think that interface is just like a electrical socket: It only expose the service inside “a black box” to the surrounding, itself does not do anything. So, when we design, we just think of “what functions the programmer have written” and then think of “how to expose this limited set of function to user”. (i.e. Not thinking the user’s need, just think of what programmer provides)

4.3 Remarkable snapshots.

In teaching methods, lectures, homeworks, objective, syllabus.. etc, this course is quite different to other courses. But in my memory, certain things are more remarkable:

Initial Test:

At the start of semester, some classmate think that it’s no more than a naughty joke. But looking back, I think this test is very useful. As what is said in the lecture, people need comparison to make decision. Now, when we look at the initial design, we know what is a good interface and what is a bad interface, and more important is that ‘What philosophy and mental decision drive the designer to make such a design’.

As the ‘worse’ and ‘better’ interface are both designed by us, we know the background idea very well. If there’s no initial test, when we look at design principles, we may think that “*naturally!, this is common sense, we know it already*” and forgot that many people, including self, usually make such a mistake. The initial test remind us to be more careful.

Room arrangement task:

This is the tutorial that do not look like tutorial. Even for some relatively-open courses, students have no chance to walk around the room and arrange the layout. It's a new experience! Also, in this tutorial, we learn that the arrangement is closely related to the understand of HCI and the model of learning. It remind us that we can get more useful conclusion and deeper understanding if we can observe carefully. E.g. when we observe traffic light, we can figure out why traffic light use red-color. because people feel more alert when that see red color and red color is always associate with "stop" and "danger".

"Wet paint!"

This is the most surprising event. No matter in what lecture or tutorial, no one ever use this way to ask student to sit in the front. If I saw this sign years before, I may probably think that it's just a naughty joke. But now I observe that – **it works !** Just a few words have such a great effect. It demonstrate the effect of text and sign to readers. Similarly, users get their hints and instruction from our interface. so, careful design of dialog and sign can ensure user use our interface effectively and in a predictable way. Also, it once again remind us that mindful observation to objects in the surrounding can get us a lot of useful information. I think that's why we have to hand in this diary.