WISDeM – a Human Computer Interactive Model for e-Learning

by

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Acknowledgements

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Abstract

This thesis proposes, demonstrates, and evaluates, a framework model, we call WISDeM (a Web-based Intuitive/Interactive Student Distance-education Model), a tutoring system that uses the student's own psychology, Communication Preference (CP), Learning Styles (LS), and Neurolinguistic Programming (NLP) Language Patterns to enhance his/her ability to remember and recall instances of knowledge. CP is the way that humans communicate most effectively using their iconic, echoic or kinaesthetic sense as their preferential channel of sensory learning input. At inception the model creates a dynamic Student Model consisting of their CP-LS and Novice| Expert (NE) factor.

Initially the thesis looks at Distance Learning Tools and Intelligent Tutoring Systems and highlights that none of these systems introduce the student user's psychology into their systems. It then discusses Communication Preference and Learner Styles and proposes a new methodology used in creating a tool incorporating Human Computer Interaction (HCI) principles and a Student Model that dynamically and interactively links a Student's updated Profile with the module content and relevant additional data so as to enhance his/her learning potential by using the student's own psychological Student Model from inception. The basis of the thesis is that, in order to make effective interactive communication more effective, the system needs to encompass HCI and the psychology of the student user BEFORE the student, as a learner, starts to use the system.

This also allows tutors, as education providers, to put the different needs of their students and educational pedagogy, and not just technology, at the centre of their attention when authoring and entering content.

The main contribution of this PhD project, in this area of research and development, looks to:

- Bring HCI and its related disciplines (computing, psychology and education) into e-learning,
- Model the student and enhance the inTS design for the student's benefit,
- Start to bridge the identified gap,
- Be guided by a flexible and Human-User Centred approach.

Abbreviations

AdminStaff	All staff authorised to administer the Administration Web
AI	Artificial Intelligence
API	Application Programming Interface
ASCII	American Standard Code for Information Interchange
ASP	Active Server Pages
ATM	Automated/Automatic Teller Machine
CAB	Correct Answer Button
CBT	Computer Based Training
CL-HTTP	Common Lisp Hyper-Media Server
CP	Communication Preference
CPLS	Communication Preference and Learning Styles
DHTML	Dynamic Hyper-Text Mark-up Language
DLT	Distance Learning Tool
DND	Dialogue Network Diagram
FAQ	Frequently Asked Questions
GIF	Graphics Interchange Format
GUI	Graphical User Interface
HCI	Human Computer Interaction/Interface
HHI	Human-human Interaction
HTML	Hyper-Text Mark-up Language
HTTP	HyperText Transfer Protocol
ID	Identifier
IE	Internet Explorer (Microsoft)
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
inTS	Intuitive Interactive online e-Learning Tutoring and Distance Learning System
ITS	Intelligent Tutoring System
JPEG, JPG	Joint Photographic Experts Group - graphics format
KISS	Keep It Simple Stupid
LS	Learning Styles
MBTI®	Myers-Briggs Type Indicator®
MS	Microsoft
NE	Novice|Expert factor
NLP	Neurolinguistic Programming
ODBC	Open Database Connectivity
PEPS	Productivity Environmental Preferences Survey
PSTN	Public Switched Telephone Network
Q&A	Question and Answers
SQL	Structured Query Language
VAK	Visual, Auditory, Kinaesthetic
VARK	Visual, Auditory, Read/Write, Kinaesthetic
VB	Visual Basic
VRML	Virtual Reality Modelling Language
WISDeM	Web-based Intuitive/Interactive Student Distance-education Model
WWW	World Wide Web
WYSIWIG	What-You-See-Is-What-You-Get

Glossary (defining terms as meant and referred to in this thesis)

Artificial Intelligence - the simulation of human intelligence processed by machines, especially computer systems and includes learning (the acquisition of information and rules for using the information), reasoning (using the rules to reach approximate or definite conclusions), and self-correction.
Asynchronous - not occurring or existing at the same time or having the same period or phase.
Avatar - an image representing a user in a multi-user virtual reality space.
Bi-polar - having two parts.
Brain Lateralization Theory - the idea that the two hemispheres of the brain have different functions: left-brain=verbal-sequential abilities and right brain=emotions-spatial holistic processing.
Brainstorming - structured, open discussion by a group of people leading to the generation of ideas to address or resolve a problem. In essence ideas are promulgated without evaluation or explanation until there are no more, the ideas are then evaluated and categorized and scored with some being rejected. The process is then carried out on each idea 'ad infinitum' until input is exhausted. Finally the most useful are adopted. Individuals can execute the process.
Cognitive Psychology - the science that deals with mental processes and behaviour that emphasizes internal mental processes.
Cognitive process - the performance of some composite cognitive activity; an operation that affects mental contents - "the process of thinking" - "the act of remembering".
Cognitive Skill - knowing a developed talent or ability, or apprehending understanding of a developed talent or ability.
Communication Preference - the selection of your own way in the art and technique of using words effectively to impart information or ideas.
Confidence Level – Normally measured at 90% or 95%. A statistical term applied to sample sizes to describe the probability that a true statistic will fall within a given range. If the confidence level is 95%, then 95 times out of 100 the population percentage, if it could be measured, would be within the confidence interval, and 5 times out of 100 the population percentage would be outside the confidence interval.
Cue Recognition - the facility to recall instances as a result of a prompt to a known instance in long-term memory or an awareness that something perceived has been perceived before prompted by a reminder, prompt, hint or suggestion.
Distance Learning - Learning that takes place when the instructor and student are separated by space and/or time. The gap between the two can be bridged through the use of technology - such as audiotapes, videoconferencing, satellite broadcasts and online technology - and/or more traditional delivery methods, such as the postal service.
Educational Psychology - the science that deals with mental processes and behaviour related to learning.
E-learning (online learning) - learning using electronic media.
Expert System - a computer program that contains a knowledge base and a set of algorithms that infer new facts from knowledge and from incoming data.
Human Centred System – is at the heart of the HCI field, it offers i) active involvement of users, ii) to make sure that human skills are used properly, iii) to allow time in project planning, iv) multi-disciplinary design, v) understanding and specification of the context of use, vi) specification of user and organizational requirements, vii) multi-design solutions, and viii) evaluation of designs against requirements by involving real user testing.
HCI – Human Computer Interaction is the study of how humans interact with computers, and how to design computer systems that are easy, quick and productive for humans to use.
HHI - Human-human interaction.
Instance - an item of sensual input that the memory receives.
Instructional-design theory - a theory that offers explicit guidance on how to better help people learn and develop. The concepts of learn and develop may include cognitive, emotional, social, physical, and spiritual.
ITS - an Intelligent Tutoring System consists of: i) a user interface, ii) an expert model, or knowledge model representing the domain expert's subject matter, iii) a student model, or

learner model representing the student, and iv) an instructional model that holds the pedagogical data.

Knowledge – the remembering of previously learned/stored material: the recall of a number of instances, from specific facts to complete theories, to working memory.

Learning - the cognitive process of acquiring or refining skill or knowledge, the storing of knowledge in long-term memory.

Learning improvement - in WISDeM refers to the fact that the inTS assists the student to measurably attain more learning using the inTS system than compared to using the system when it does not take cognisance of his/her profile.

Learning Styles – the sixteen styles made up out of from four couplets types: Extrovert|Introvert, Sensing|iNtuition, Thinking|Feeling, and Perception|Judgement.

Memory -

- **Cognitive** - memory that is consciously known at a specific moment.
- **Echoic** - the persisting effects of auditory stimuli
- **Episodic** - the facility to relate instances to each other using occurrence time to relate each to the other
- **Haptic** - the persisting effects of touch stimuli
- **Iconic** - the persisting effects of visual stimuli
- **Instance of** - an episode of Memory, the initial learning something, some item of knowledge.
- **Kinaesthetic** - movement, touch, emotion, and feeling.
- **Meta** - differentiating and discriminating one's own
- **Procedural** - *long-term memory*, remembering operations or ways of doing things
- **Reference Library** - *long-term memory*, remembering facts, words, instances
- **Semantic** - *word store memory*, where language is stored and related to instances
- **Technical Library** - *long-term memory*, remembering methods, modus operandi, procedures, and skills.

Meta-cognitive skills - knowing the way your own mind works.

Modality

- **Auditory** - use of auditory imagery: hearing, tonality, pitch, melody, volume, and tempo
- **Kinaesthetic** -use of emotional, feeling, movement imagery: intensity, temperature
- **Visual** - use of visual imagery: sight, colour, brightness, contrast, focus, size, location, and movement.

Neurolinguistic Programming - the Study of the Structure of Subjective Experience and what can be calculated from it.

Motivation - The driving force within that causes an individual to act in order to achieve a specific goal.

Observational Evaluation – observing subjects using the system and collecting information about what they do or do not do.

P-value - represents the probability of a result of a test of association having occurred by chance if there was actually no association between the variables. Probability values can only lie between 0 and 1, and P-values never actually reach 0 or 1. If the P-value is less than 0.05, it signifies that a result like this could only have appeared by chance 5% of the time if no association actually existed - this is a statistically significant finding.

Pedagogy – The art and science of teaching.

Perceptual

- **Constancy** - the assumption that things generally remain the same.
- **Organization** - the organization of instances using Similarity, Proximity, Continuity and Closure to categorize an instance.
- **Selectivity** - the selection of those instances that are to be accepted as input.
- **Readiness** - using Knowledge and interest, Previous experience, Personality traits, Social and cultural influence, and Functional fixedness.
- **Skill** - judging good work and recognising defects.

Psyche - the immaterial part of a person; the actuating cause of an individual life.

Psychomotor Skill - carrying out the physical task.

Remembering - the act of storing sensual input into the memory and, after a period of time, recalling an instance and/or a group of instances either consciously or subconsciously.

Socratic Method - teaching by asking a series of questions.

Subliminal Text Message - a text message that is below the threshold of conscious perception.

T-value - T-test measures the difference between the means of the two populations of which the data is a random sample.
Trouble-maker - an agent introduced to an ITS where it has a level of competence that is superior to that of the student in order to provide reasonable competition. It has pedagogical knowledge that can help it to plan interactions efficiently.
Wizard of OZ – a technique where a developer has a concept of a computer system. Actually it is a simulation provided by either a human (referred to as the wizard) or the combination of a human and a computer. Executed individually requires deep conceptualization and the consideration of many 'What-Ifs'.

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CHAPTER 1

INTRODUCTION

1 Introduction

Chapter 1 introduces the:

- Project's Motivation that explains how the concepts started.
- Research Rationale and Hypotheses on which the thesis is based.
- Project's Main Contribution to academia.
- Description of WISDeM as an intuitive interactive online Distance Learning Tool and what gaps have been covered by the system.
- Thesis Overview of each chapter.
- List of Published Papers for this PhD project.

1.1 Project Motivation

Peoples experience, including the author's, of a number of Distance Learning Tools was that, whilst they achieved an objective of containing and presenting knowledge extremely well, the experience of using them fell far short of normal human-human interaction (HHI), was flat and gave no rewarding motivation. The user had to accept a standard presentation that did not vary from user to user – briefly there was no real human-computer interaction (HCI) that approached HHI, and, thus, the learning experience lacked the quality that was required to make it as effective as it should be.

The project was motivated by the concept that a virtual university should be, to the student, an online distance learning environment that is capable of being transmitted via the world wide web by an intuitive interactive tool, a simulation of the real-world learning experience and, at all stages, interacts with the student's changing profile whilst it provides the required motivation and rewards.

1.2 Research Rationale and Hypothesis

The concept of creating a human-computer interaction that matched human-human interaction formed this project's main motivation and objective. Solving any large problem may seem daunting, indeed so daunting that 'it is better not to start' – initial comments from peers from different parts of academia suggested that 'the project was too difficult'.

Completing the whole of HHI to HCI replication will take many years of research and development by different researchers. This thesis is viewed as a step in this direction and process. It uses the following basic hypothesis: "*Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning*".

To attain this goal two psychometric tests establish the student's Communication Preference and Learning Styles. Then Neurolinguistic Programming language patterns, Motivational Factors, and a Novice/Expert Factor are used to create the Student Model. The design uses knowledge of 'the Way We Learn' in the interface.

1.3 Project's Main Contribution

The main contribution of this PhD project, in this area of research and development, looks to: i) Bring HCI and related disciplines (computing, psychology and education) into e-learning, ii) Model the student and enhance the inTS design for the student's benefit, iii) Start to bridge the identified gap, and iv) Be guided by a flexible and Human-User Centred approach. To achieve these goals the project replicates HHI in HCI in the WISDeM system that successfully introduces an HCI that matches each student's psychological requirements with reference to matching his/her communication preference and learning styles. WISDeM also introduces a measure of motivational reward and statistical reporting that matches each user's psyche.

In short the project's main contribution is that the student has a system that matches his/her own personality and thus enhances his/her ability to learn – enjoy the experience, remember and recall knowledge significantly more than without a match.

1.4 WISDeM as an online intuitive interactive Distance e-Learning Tool

WISDeM[1] (William A Janvier & Ghaoui, 2001) has been developed to offer a Human-Centered Generic intuitive/interactive online Distance Learning Tutoring System (inTS) for higher education. Gagne's research into the "Conditions of

[1] **WISDeM** - Web-based Intuitive/interactive Student Distance-education Model is a generic development of Dr Claude Ghaoui's ProFlexLearn system developed since 1996/97 (Claude Ghaoui, 1997).

Learning"[2] (Sporre, 2001) highlights the requirement for one-to-one interaction between student and tutor: not always practical in the modern university. The project's research also indicates that the marrying of a DLT with an Intelligent Tutoring System (ITS) in a generic manner to produce a Human-Centred ITS tool for the WWW would be beneficial to a student (Djian et al., 1999).

In general, the project's research shows that a DLT is expected, as far as possible, to i) emulate learning 'in-situ', ii) support both the tutor and the student by being able to replicate the tutor's advice and direction, iii) be able to function at some remote time and place on a 24/7/365[3] basis, and iv) support the growing paradigm shift from Teaching Theory[4] design, where modules are designed primarily to satisfy what/how teachers wish to present information - leading to possible student confusion[5] (S. Ainsworth, 2000), to a student-centered/Learning Theory design (Duchastel, 1998). The student should find the system intuitive to use with either an Intranet or Internet browser with the DLT encompassing i) Self-Directed learning (English & Yazdani, 1999), and ii) Asynchronous and Synchronous communication (Phillos et al., 1999; Turgeon, 1999; Wang et al., 2000). In this project research has shown that the accepted standard is that a student must be able to experience Self-Directed Learning and Asynchronous and Synchronous communication.

(Bouras & Philopulos, 2000) consider that using a combination of HTML, Java and the VRML, makes acquiring knowledge easier by providing such facilities as *Virtual Chat Rooms* for student-student-teacher interaction, *Lectures* using the virtual environment, *Announcement Boards*, *Slide Presentations* and *Links to WWW* pages. (A'Herran, 2000) provides an excellent presentation of the various components usually offered.

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[2] **Gagne's nine events of instruction** for the human learning/memory model are: i) Gaining attention, ii) Informing the student of the objective, iii) Stimulating recall of prior learning, iv) Presenting the stimulus, v) Providing learning guidance, vi) Eliciting the performance, vii) Giving the informative feedback, viii) Assessing performance, ix) Enhancing retention and transfer. The designer is required to design instruction that would be expected to make the most of the kinds of variables that lead to effectiveness of learning in the one-to-one tutoring situation.

[3] **24 hours per day**, 7 days per week, 365/6 days of the year

[4] **Teaching Theory** - (Major & Ainsworth, 1997b) take the view that different teaching styles need to be taken for different domain areas and students. In essence, to maximize results, each student needs to be categorized (S. E. Ainsworth et al., 1999).

[5] Research has also shown that different teachers adopt different strategies for the same student. Thus allowing teachers to adopt their own preferences and teaching theories produces: for the same student, a different path and selection through the course material. It was found that there were strong inter-author differences in what was taught as well as in the order in which it is taught (S. Ainsworth, 2000).

WISDeM offers the necessary Intuitive Interaction whilst maintaining at all times the KISS (Lampson, 1983) principal (Keep It Simple Stupid).

1.5 Brief Summary of WISDeM's functionality

To summarize, WISDeM offers the main facilities of a modern DLTs PLUS Intuitive Interaction, whether the student is a low or high skill student (Lamberti & Wallace, 1990), has a communication preference that is iconic, auditory or emotional and matches the requirements of any one of the sixteen personality types. The system wraps an intuitive cover around the interactive learning modules, creating an interaction between the student and the system that is seamless. As the student interacts with the WISDeM, it watches how a student proceeds through the material and, from the observations it makes, records what the student knows, what the student does not know. The system either takes action autonomously or by the student's request according to the student's psyche.

1.6 Thesis Overview

This thesis is split into an introductory section, nine reporting chapters and an Appendix of supporting information.

Chapter 1 - Introduction

This chapter introduces the project's motivation and explains how the concepts started, it covers the research rationale and hypothesis on which the thesis is based, discusses the projects main contribution to academia, provides a description of the WISDeM system as an online intuitive interactive distance learning tool, the gaps that have been successfully addressed by it and provides a thesis overview of each chapter. It finally lists published papers.

Chapter 2 – Literary Review – Distance Learning (and E-learning) & Intelligent Tutoring Systems

This chapter reports on a literary review of selected Distance Learning Tools (DLT) – online learning and includes a précis of the Blackboard™ and WebCT™ reviews. It then reports on a literary review of selected Intelligent Tutoring Systems (ITS) providing a brief overview of their history and an analysis/comparison of some representative systems. It finally highlights the gap, which exists, that WISDeM starts to cover.

Chapter 3 – Communication Preference & Learning Styles

This chapter introduces communication preference and neurolinguistic programming (NLP) and the part they play in inter-personnel communication and then introduces NLP eye-gaze and language patterns. It discusses learning styles (is their use justified?) and briefly covers the Dunn & Dunn Learning Style model, Kolb's Learning Style inventory, the Myers-Briggs Type Indicator® (MBTI®) including its reliability and validity, VARK Learning Style Preferences, motivational learning (Maslow's Motivational Hierarchy of Needs), Gagne's Hierarchy of Learning, and in the summary, introduces the important elements that have been encapsulated in the WISDeM system from this chapter.

Chapter 4 – WISDeM - Framework

This chapter describes WISDeM's framework by covering the overall architecture and the initial student profile creation. This provides details of the way the student profile is created, pseudo code that provides top-level code data outlining the treatment of a new or existing user, dialogue network diagrams that cover the main aspects that make up WISDeM's interactive essence. Then the expanded model diagram illustrates the various components and data flow of revision intuitive interactive multi-choice Q&A.

Chapter 5 – WISDeM – Intuitive Interaction

This chapter discusses student learning styles and teaching styles, then it looks at the student profile: i) the initial student profile model (communication preference (CP) and learning styles (LS) test output and validation), ii) the initial student profile development (CP & LS algorithm pseudo codes). It goes on to discuss the development of the CP questions and the development of LS and finally covers the knowledge and motivation used in WISDeM and its pedagogical standards.

Chapter 6 – Design & Development

This chapter overviews the timescale over which WISDeM has been developed, outlines the basic design concepts used and the way the five principles of good design were incorporated in the system's development. It then provides details of the various tools used in the system and in developing it, outlines in more detail the design and development in years one and two (core distance learning section), and, in year three plus, the design and development of the intuitive interactive section of the multi-choice Q&A and the administrative system.

Chapter 7 – A Scenario

This chapter introduces Adrian, a composite student who uses the system. Adrian is made up from a number of students who used the system. The scenario starts with the logon and covers the functionality of the intuitive interactive part of WISDeM. It reports on how the initial profile is created, on Adrian using both topic learning and topic testing and how the system dynamically maintains his profile. It also interposes insight into what the system is actually doing and why.

Chapter 8 - Evaluation

This chapter reports on WISDeM's evaluation. It discusses usability evaluation (methods and statistical requirements), covers the evaluation planning (objectives, what needed to be evaluated, ethics clearance and success criteria – design and rationale) and then discusses the execution of the evaluation. Finally it discusses in depth the actual evaluation results covering the anecdotal, subjective and statistical evidence (analysed using the two-sample T-test and ANOVA) drawn from the evaluation of the logon and creation of the initial student profile and then from the inITS multi-choice Q&A facility. It concludes by a summation of the evaluation exercise whose outcome significantly supports the hypothesis.

Chapter 9 – Conclusion and Some Suggested Future Work

This chapter briefly covers the projects main contribution, summarizes each chapter and suggested possible future work.

1.7 Published Papers

This is a list of papers published. Each has a brief overview of the paper.

Janvier, W. A., & Ghaoui, C. (2001, September). *Searching for WISDeM, the Holy Grail of Intelligent Distance Education.* Paper presented at the HCT2001 Workshop - Information Technologies and Knowledge Construction: bringing together the better of two worlds, University of Sussex, Brighton.

Initial research looked at current Distance Learning Tools (DLT) and Intelligent Tutoring Systems (ITS). It aims to bring in together both areas for developing a KISS (Keep It Simple Stupid) generic Distance Learning Intuitive Interactive system. This project is a continuation of an ongoing research and development into Online Flexible learning since 1997 and builds on an earlier prototype.

Janvier, W. A., & Ghaoui, C. (2002, 26-27th Sept). *WISDeM: Communication Preference and Learning Styles in HCI.* Paper presented at the HCT2002 Workshop - Tools for thought: Communication and Learning Through Digital Technology, Brighton, UK.

This paper is based on the Research Hypothesis that "*Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning*".

Janvier, W. A., & Ghaoui, C. (2002, 1-4 November). *WISDeM - Student Profiling using Communication Preference and Learning Styles mapping to Teaching Styles.* Paper presented at the APCHI 2002 - 5th Asia Pacific Conference on Computer Human Interaction, Beijing, China.

This paper discusses a Distance Learning Tool and outlines WISDeM's (Web Interactive Student Distance-education Model) Architecture, current and future development. The whole emphasis of the research is that a Generic Interactive Tutoring System should exhibit the "Keep-It-Simple-Stupid" (KISS) principle for all stakeholders: there is a lack of research linking data in Distance Learning Tools databases, Tutorial HTML pages, hyperlinks and Intuitive Interaction in a generic manner. The paper also discusses establishing a Student's Profile using Communication Preference and Learning Styles automatically mapped to Teaching Styles, Neurolinguistic Programming Language Patterns, and WISDeM's architecture, current development, initial results and future work.

Janvier, W. A., & Ghaoui, C. (2003, 18-21 May). *WISDeM and E-Learning System Interaction Issues.* Paper presented at the 2003 IRMA International Conference, Philadelphia Pennsylvania, USA.

This paper discusses interaction between the computer interface and the user in e-learning. Catania 1992 reports that sensory input is mainly derived from iconic 60%, auditory 30%, and haptic 10% with little from olfactory and gustatory. Driscoll and Garcia 2000; Fleming 2001; Fleming and Mills 1998; Fuller et al. 2000; Murphy et al. 2002 show that everyone has his/her own preference for exchanging ideas, acquiring and passing on knowledge. Sadowski and Stanney 1999 report that there is a tendency to prefer one sensory input (visual, auditory or kinaesthetic - tactile/haptic) whilst Fleming 2001's research shows that most students prefer multi-modal communication.

Janvier, W. A., & Ghaoui, C. (2003, September 3-5). *Using Communication Preference and Mapping Learning Styles to Teaching Styles in the Distance Learning Intelligent Tutoring System* - WISDeM. Paper presented at the Knowledge-Based Intelligent Information and Engineering Systems - 7th International Conference - KES 2003, Oxford, UK.

This paper discusses interaction between the computer interface and the user in e-learning. (Janvier and Ghaoui 2001; Janvier and Ghaoui 2002a; Janvier and Ghaoui 2002b) consider that correct inter-communication style should be established and started before learners commence their e-learning: their research hypothesises is "*Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning*".

Ghaoui, C. & Janvier, W. A. (2004, May 23-26). *Interactive E-Learning.* Paper presented at the 2004 IRMA INTERNATIONAL CONFERENCE - Innovations Through Information Technology, New Orleans Marriot Hotel, New Orleans, LA, USA.

This paper introduces the new concept of improving student memory retention using a Distance Learning Tool by establishing the student's Communication Preference and Learning Style BEFORE the student uses the module contents.

It argues that incorporating a Distance Learning Tool with an Intuitive/Interactive Tutoring System using various components (Psychometric tests, Communication Preference, Learning Styles, mapping Learning/Teaching Styles, Neurolinguistic Programming language patterns, Subliminal Text Messaging, Motivational Factors, Novice/Expert Factor, Student Model, and the Way We Learn) combined in WISDeM to create a Human-Computer Interactive distance e-learning tool does indeed enhance memory retention.

The authors show that WISDeM's evaluation indicates that a student's retained knowledge has been improved from a mean average of 63.57% to 71.09% - moving the student from a B to an A.

Ghaoui, C., & Janvier, W. A. (2004). *Smart ProFlexLearn: An Intuitive Approach to Virtual Learning Environment,* In: E-Education Applications: Human Factors and Innovative Approaches, IGP, USA, (ed. Claude Ghaoui), pp 66-83.

The chapter looks at the background of Distance Learning Tools (DLT), the development of "Promoting Flexible Learning" (ProFlexLearn) as a DLT, the background of Intelligent Tutoring Systems, introduces Learner Profiling (Communication Preference, Learning Styles and motivational factors), the development of ProFlexLearn into a Web Intuitive/interactive

Student Distance-education Model (WISDeM), and its architecture and future improvement as a generic Intuitive Interactive Tutoring System.

Janvier, W. A., & Ghaoui, C. (2004b). *An evaluation of the learner model in WISDeM*, international journal of Interactive Technology and Smart Education (ITSE) (Troubador Publishing Ltd), Vol 1, No 1 Feb 2004; pp 55-66.

This paper discusses an evaluation study of WISDeM, an interactive Distance Learning Tool. It covers the evaluation rationale, details of usability evaluation, designing the evaluation, the objectives and respondents, the study, the raison d'être for the questions asked and basic assumptions, what needed to be evaluated, the execution of the evaluation, its results and conclusions. The evaluation results indicated that Communication Preference and Learning Styles matching between a computer interface and the student user is likely to enhance his/her ability for memory rehearsal, learning and knowledge recall more effectively than without it.

CHAPTER 2

LITERARY REVIEW

DISTANCE LEARNING (E-LEARNING)

AND

INTELLIGENT TUTORING SYSTEMS

2 Literary Review – Distance Learning (E-learning) & Intelligent Tutoring Systems

This chapter reports on:

- Literary Review of some Distance Learning Tools (DLT) – e-/online learning including a précis of the Blackboard™ and WebCT™ reviews.
- Intelligent Tutoring Systems (ITS) providing a brief overview of REEDEM and an analysis/comparison of some representative systems.
- The summary highlights the gap that exists, which WISDeM starts to cover.

2.1 Introduction

The rationale of the literary review was to investigate a range of DLT and ITS. The methodology adopted for each was similar with both having the same criteria. The research was instigated to establish some background about each tool (their Model and Details) and to establish what functionality each (DLT and ITS) offered in order to obtain information from which gaps in development and functionality were exposed. Human-human interaction (HHI) in counseling and teaching improves communication and learning (Larkin-Hein & Budny, 2000), the literary review also investigated what elements of this has been included these tools and systems, in particular it looked for the inclusion of Communication Preference (CP) and Learning Styles (LS). Chapter 3 covers CP, LS, HHI and HCI (see Fig.1 – Human-human interaction in DLT and ITS?).

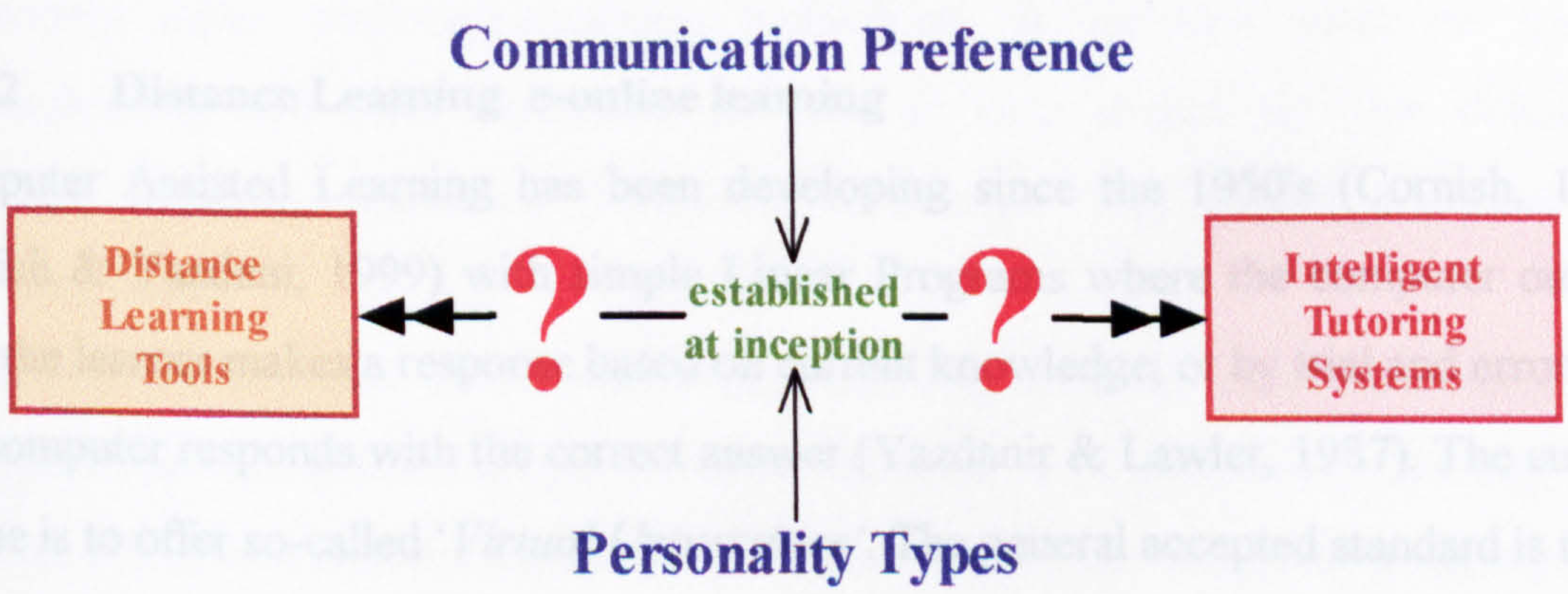

Figure 1 - Human-human interaction in DLT and ITS?

- ***The commonality of the comparison*** looked at:
  - The method of delivery of the tool: Internet/LAN/PC or Intranet/LAN or Pc only.
  - Whether or not the tool offered an
    - Intuitive Interactive Tutoring System (inTS)
    - Communication Preference (CP) assessment at inception
    - Learning Style (LS) assessment (with reference to personality types) at inception

  that dynamically changes interface the student is using.
- ***The questions posed only to DLT*** covered their content with regard to:
  a) *Content Module*: Syllabus – Search Facilities – Course Notes and Materials – Task setting – Library facility.
  b) *Communication Tools*: Forum/Discussion Board – Email facility for users – Chat – Whiteboard – Calendar – Announcement facility.
  c) *Assessment tools*: Quizzes – Surveys – Self-test – Assessment tools.
- ***To add depth***, the two most popular DLT, Blackboard™ and WebCT™, are reported on in a précis review: these reviews are symptomatic of the majority of DLT and cover all of the facilities that are offered except for CSCW functionality. In addition REDEEM is covered in depth due to its facility to match its interaction with students' learning styles as perceived by their tutors.

The review exposes the gaps not covered by either DLT or ITS: all systems do not establish the student's actual communication preference and learning styles (with relation to their personality types) at inception.

2.2 Distance Learning e-online learning

Computer Assisted Learning has been developing since the 1950's (Cornish, 1999; English & Yazdani, 1999) with simple Linear Programs where the computer outputs text, the learner makes a response based on current knowledge, or by trial and error, and the computer responds with the correct answer (Yazdanir & Lawler, 1987). The current vogue is to offer so-called '*Virtual Universities*'. The general accepted standard is that a learner must be able to experience Self-Directed Learning, Asynchronous and Synchronous communication.

(Bouras & Philopulos, 2000) in their paper consider that '*Distributed Virtual Learning Environment*', using a combination of HTML, Java and the VRML (Virtual Reality Modelling Language), makes acquiring knowledge easier by providing such facilities as *Virtual Chat Rooms* for learner-learner-teacher interaction, *Lectures* using the virtual environment, *Announcement Boards*, *Slide Presentations* and *Links to WWW* pages.

(Cooper, 2000) research shows that Post-secondary institutions want to offer on-line courses to meet the educational needs of a fast-paced, computer literate society.

2.2.1 Distance Learning Tools - general facilities

(JCU, 2000)'s presentation at UMIST in Manchester, UK, in September 2000, reported on research into DLT. The research assessed nineteen headings that, the researchers considered, every online system must contain: 1) Scalability, 2) Value for money, 3) Integration with existing systems, 4) Robustness, 5) User base, 6) Technical support, 7) Customizability (system – courses), 8) Ease of maintenance (Tutors, course developers, technicians), 9) Flexibility, 10) Integration of legacy materials, 11) Consistent, uniform framework, 12) Accessibility, 13) Quality of design, 14) Will it provide increased and improved access to resources? 15) Will it streamline our administrative procedures? 16) Will it give secure personalized access to information and services? 17) Will it enable down-the-track e-commerce and smart card technology? 18) Will it improve IT literacy as part of a generic skills base? 19) Will it improve collaboration between University programs? As a result of their research JCU purchased Blackboard 5™.

(Hegarty et al., 1998) provide a step-by-step guide for setting up Distance Learning classrooms using telecommunications technology. It includes notes on testing, troubleshooting and other references as well as case studies for five distinctive 'Distance Learning' scenarios developed in Europe. The project addressed the following issues:

a) Access to educational media/technology, including access by people with disability.
b) Ease of set-up, adaptation, operation and maintenance of the media/technology.
c) Cost effectiveness of the media/technology employed, and installation, management and technical support.
d) Ease of use/user friendliness and ergonomics of the interfaces, dealing with sociological, environmental and cultural aspects.
e) Cross-cultural issues (including language)

f) Issues related to gender, to ensure positive participation of women in the design, development and use of the technology.

g) Basic technical quality and standards expected, use of existing technical and telecommunications norms and standards, and accessibility to a wide variety of both available and future telecommunications modes (PSTN, ISDN, ATM, Data, Computer conferencing, e-mail, audio, video, graphics, videoconferencing, broadcasting, etc.).

h) The existence of educational support (e.g. on-line services, resources, tutor assistance etc.).

2.2.2 Distance Learning Tools Evaluation

An in-depth evaluation of both Blackboard 5™ and WebCT™ revealed that much attention has been given to accommodating the learner and to providing excellent facilities. The typical facilities are:

- *Content Module*: Syllabus, Compile Pages, Glossary, Search, Index, CD-ROM, Movie/Audio clips, MyNotes tool, Resume, Image Database, Bookmarking, Links, References, Targets, WebCT Library.
    - Syllabus is considered as an important inclusion for all students in that it explains the course material, what they are expected to do, and how they will be graded/evaluated.
    - Search Facilities (including Search, Glossary, Index, Links and References) provides the facility to search for specific requirements and allows the student to find topics more easily and aids revision.
    - Course Notes and Materials (including CD-ROM and Movie/Audio clips) are of particular importance in that they provide students with a wide range of facilities. The materials need to cover the different way students learn so as to help and support learning (see Chapter 3).
    - Task Setting (including Targets) – some students learn more easily where they are set tasks and/or asked to meet targets, it is a basic requirement for different personality types (see Chapter 3).
    - Library (including image database and references) provides the student with research materials that are basic to all personality types' requirements.

- *Communication Tools*: Asynchronous attendance forums, E-mail, Synchronous Chat and Whiteboard, Calendar, Learner Presentation Tool, Learner Homepage Tool.
    - Asynchronous and E-mail facilities match the requirements for many personality types in that they allow the student to take time to learn and thus feel under less pressure than they experience with synchronous communication: this can be particularly so for the introvert personality type (see Chapter 3)
    - Synchronous communication (e.g. Whiteboard) facilities match the requirements of the extravert personality type and thus enhance their learning experience (see Chapter 3)
    - Other communication tools add facilities for both the extravert and the introvert, thus widening their learning potential (see Chapter 3).
- *Assessment tools*: Quizzes, Surveys, Self-test, Assignments, My Grades, My Progress, The Grade Book.
    - Quizzes and Self-tests are of particular help to both the student who likes to take time and those who like 'things done yesterday' provided that the way that they are presented match their personality requirements (see Chapter 3).
    - Grades and Progress reports/details fit well with all students; however, the analytical and fine detailed type students find these of particular importance and provide some cover for their requirement for recognition and reward (see Chapter 3).

Thus the typical features are designed to 'fit all' and allow each individual student to extract from the facilities what they want and to use their own particular learning style: but, do the various tools actually try to match 'Communication Preference' and 'Learning Styles' and does this enhance remembering?

Note: See References & Web References, Fig.2 & Fig.3 for the following reports.

2.2.2.1 Blackboard™

Following the initial development by Cornell University, Blackboard™ was founded in 1997 with a clear vision to transform the Internet into a powerful environment for teaching and learning to provide the world with technology (meaning opportunity, not complexity) allowing:

- Administrators to more easily support the faculty, strengthen their educational communities, and foster lifelong relationships between their institution and student/users.
- Authors/Teachers to extend their expertise and guidance beyond the classroom - to students on campus, across town, or even across the world.
- Learners/Students to reach teachers, interact with classmates, and access learning materials anytime, anywhere.

Blackboard 5™ is an e-Learning software platform encompassing a course management system, customizable institution-wide portals, online campus communities, and an advanced architecture allowing easy integration of multiple administrative systems. The years of research and feedback from their global user base has created, what they claim to be, "*the most comprehensive, scalable platform to date*". The system is used by 1,000+ institutions, serves 3.5 million+ active users, in 70+ countries. In addition more than 5,500 institutions use Blackboard's web site to provide services (A'Herran, 2000).

Blackboard 5™ can be licensed at three levels: 1) Course Manager, 2) Course and Portal Manager and 3) Advanced Course & Portal Manager.

- *Course Manager*: delivers the course management tools enabling authors/tutors to provide student/users with course materials, discussion boards, virtual chat, online assessments and a dedicated academic web resource centre.
- *Course & Portal Manager:* adds to 1) the facility to customize/institution-brand sites for faculty, student/users, staff, and alumni providing more than 150 web personalized news and information services from across the Web. It facilitates campus online communities, Web-based email, calendar, announcements, tasks and a central access point for all the university's online services.
- *Advanced Course & Portal Manager:* adds to 2) advanced Java-based API's. These provide a user-driven-single-logon service and customizable sites for each school, department or campus.

It is an excellent Distance Learning Tool for student/users. It is well designed with clear hyperlinks and text. Throughout all pages the top frame is the same. It displays buttons for 'Home', 'Help' and 'Logout'. The system provides the student/user with three sections: 1) My Institution, 2) Courses and 3) Academic Web Resources. The upper frame only uses about 20% of the total screen depth on an 800x600px browser. All content pages are loaded into the lower main frame. This provides ample space at all times to view the contents provided no sub-frame headers are introduced. Some pages do include sub-frames and can reduce the available tutorial screen to less than 30% of the total.

- Overall the system is intuitive to use with all sections functioning well.
- The standard top frame contains the same hyperlinks throughout and, in Courses; there is a standard left frame of image links.
- The use of standard icons throughout aids navigation.
- The 'course map' is particularly useful.
- The Student Calendar is very useful.
- The category division between My Institution, Courses and Academic Web Resources makes the whole site very easy to use.

Blackboard 5™ does not recognize a student's psychology or dynamically model the student's profile or offer any acknowledgement of the student's communication preference or learning styles (with reference to their personality types) at inception.

2.2.2.2 WebCT™

WebCT™ was launched in September 1998 having begun life as a university-based project developed by University of British Columbia, Canada. In the first 16 months WebCT™ (to February 1, 1999) sold over 1200 licenses to institutions in over 33 countries with a renewal rate for licenses running at approximately 90% (a license can range from one course to 1000 or more). WebCT™ facilitates the creation of sophisticated World Wide Web-based educational environments. It provides an interface allowing the design of the presentation of the course. It provides a set of educational tools to facilitate learning, communication and collaboration. It provides a set of administrative tools to assist the instructor in the process of management and continuous improvement of the course. The student interface is available in many languages, including English, Spanish, French, Dutch and Finnish with more planned and is used in over 61 countries (see http://www.webct.com/ and (Marshall-University, 1999)).

The WebCT™ web browser (client-server) model consists of Apache web server software running pre-compiled executable Perl script, CGI, a Chat server, a Whiteboard server and data files. It serves five types user:

- Administrator - creates the course/module
- Designer – adds design elements (page colours, etc) and adds content/material
- Helpdesk user – acts as the ongoing service agent to the system's users
- Teacher/assistant - adds content/material
- Student - uses the system.

The system can link to external files using normal web hyperlinks and can thus access files created by any normal e-communication package.

It is an excellent Distance Learning Tool for students. It is well designed with clear hyperlinks and text. Throughout all pages the left frame and top frame remain allowing **only** the white section to change to take content. The problem with this design is that, later down the hierarchy of screens, part of the white screen also uses frames. This results in the effective screen space being reduced to 30% (of the total available screen space) for tutorial content. This is combated by allowing the user to 'hide' the left navigation frame and use the 'Course Map' (top frame hyperlinks) to navigate.

- Overall the system is intuitive to use with all sections functioning well.
- The standard upper and left side frames contain the same hyperlinks throughout.
- The facility to hide the left frame (expand content and hide navigation) gives the user more useful space.
- Standard icons throughout aids navigation.
- The facility on the front page to 'resume course' where you last left off is very useful. The link takes you to the last page you where viewing in the Course Notes.
- The 'course map' is particularly useful. It replicates the left frame.
- The use of text as links in the left frame increases the number of links that can be included without going off the user's window and also provides some acknowledgement of accessibility.
- The system provides the student with four sections: 1) Module Content, 2) Communication, 3) Student Tools and 4) Coursework
- The facility for a student to create a personalized 'Study Guide' is useful.
- The Student Calendar is very useful.

- The 'Discussion Forum' is very well designed and easy to use
- The category division between Course Content, Communication, Student Tools and Coursework provides easy navigation for the learner.
- The facility for Individuals and Groups to have their own web site is useful.

It does not recognize a student's psychology or dynamically model the student's profile or offer any acknowledgement of the student's communication preference or learning styles (with reference to their personality types) at inception.

2.3 Distance Learning Tools Summary

The following figures (Fig.2 & Fig.3) lists the DLT reviewed and Web References provides the source. Practically all the tools were found to contain very similar functionality as discussed above.

		Content Module					Communication Tools					Assessment Tools			
System Name	Del	Syl	Sch	Crs	Tas	Lib	Frm	Eml	Cht	WhB	An	Qz	Srv	Slf	AsT
Blackboard	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Convene	Int	√	√	√		√	√	√	√		√	√			√
Digital Learning Interactive	Int	√		√	√	√		√			√	√	√	√	√
Docent Connection	Int	√		√	√		√	√	√	√	√	√	√	√	√
eCollege	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Eduprise	Int	√	√	√		√		√				√			√
e-education	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Embanet	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
eSocrates	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
eWebClassroom	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Integrated Virtual Learning Environment	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
IntraLearn	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
LearnLinc5	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Lotus Learning Space	Int	√	√		√		√	√	√	√	√	√	√	√	√
LUVIT	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PathLore	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Serf	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
TeacherUniverse	Int		√	√		√		√				√			√
The Learning Manager	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
TopClass	Int	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Web Mentor	Int			√	√	√	√	√	√	√	√	√		√	√
Web Course Builder	Int			√								√	√	√	√
WebCT	Int	√	√	√	√		√		√	√	√	√	√	√	√
XanEdu	Int		√	√		√		√							

Detail	Symbol	Delivery	
Yes	√	Internet/LAN/Pc	Int
Partial	√p	Intranet/Local Area Network	Lan
Not reported	space	Personal Computer ONLY	Pc
Content Module		Communication Tools	

Syllabus	Syl	Tasks	Tas	Forum/Discussion Board	Frm	Whiteboard	WhB
Search	Sch	Library	Lib	Email	Eml	Announcements	An
Course Notes/Materials	Crs			Chat	Cht		

Assessment Tools			
Quizzes	Qz	Assessment Tools	AsT
Surveys	Srv		
Self-test	Slf		

Figure 2 - Reviewed Distance Learning Tools

Also see (Lai, 1993; Lieberman, 1997; Lieberman, Dyke et al., 1999; Lieberman, Nardi et al., 1999)

System Name	Model details & Notes	Del	DL	inTS	CP	LS
Blackboard	It offers online teaching and learning, campus communities, campus commerce services, and integration of Web-enabled student services and back office systems. It offers the normal Distance Learning Tool functionality.	Int	√			
Convene	It was established in 1993 and offers eLearnGate, their portal, serves as the gateway to eLearning platforms - IZIO and Campus Spectrum a management tool. It offers most of the normal Distance Learning Tool functionality.	Int	√p			
Digital Learning Interactive (Thompson's iLrn)	iLrn offers the facility to create modular material including tests, and whilst it only offers some of the normal Distance Learning Tool functionality, all its modular material can be exported to systems like Blackboard.	Int	√p			
Docent Connection & Toolbook Assistant (Sum Total)	It offers the facility to create modular material including tests. It offers the normal Distance Learning Tool functionality and, in addition, also incorporates the current Computer Supported Cooperative Work functionality.	Int	√+			
eCollege	It supports all aspects of online teaching and learning. It offers full online course delivery, Textbook supplements, Student research engines, Journal & magazine articles, Stand alone eLearning topics, Full eLearning courses, Testing and profiling tools, "Real-life" simulations and Online labs. It works in collaboration with Microsoft. It offers the normal Distance Learning Tool functionality.	Int	√			
Eduprise (Sunguard Collegis Inc)	It offers the facility to create modular material including tests, and whilst it's overall functionality does not include the normal Distance Learning Tool facilities, all its modular material can be exported to systems like Blackboard.	Int	√p			
e-education	Is a course management and delivery platform that covers the necessary e-learning tools for assessment, communication, collaboration, community building and creation and management of online learning courses. It offers the normal Distance Learning Tool functionality.	Int	√			
Embanet	Is a fully hosted and supported e-Learning solution to educational Institutions, it covers the necessary e-learning tools for assessment, communication, collaboration, community building and creation and management of online learning courses. It offers the normal Distance Learning Tool functionality.	Int	√			
eSocrates	Is a hosted and supported e-Learning solution to educational Institutions, it covers the necessary e-learning tools for assessment, communication, collaboration, community building and creation and management of online learning courses. It offers the normal Distance Learning Tool functionality and, in addition, the group inter-communicability of their Dynamic Virtual Community™.	Int	√+			
eWebClassroom (eWebUniversity)	It offers a system for creating Lecture Notes, Quizzes and Tests, Discussion Groups, Offline Usage, Integration between Student Information Systems and eWebClassroom and Integration between Academic Information Systems and eWebClassroom. It offers the normal Distance Learning Tool functionality plus some CSCW functionality.	Int	√+			
Integrated Virtual Learning Environment	It offers online teaching and learning, campus communities, campus commerce services, and integration of Web-enabled student services and back office systems. It offers the normal Distance Learning Tool functionality.	Int	√			

IntraLearn	It offers an integrated suite of products that includes authoring, content management, collaboration and skills management as well as a learning management system to deliver, measure and manage learning over the Internet and intranets. It offers the normal Distance Learning Tool functionality.	Int	√				
LearnLinc	LearnLinc is a comprehensive eLearning application that provides a highly secure and reliable platform for online training offering the normal Distance Learning Tool functionality plus some CSCW functionality.	Int	√+				
Lotus Learning Space (Lotus e-learning)	IBM Lotus has updated its e-learning software product family and now offers - Lotus Virtual Classroom, Lotus Learning Management System, and Lotus Workplace Collaborative Learning. It integrates with other Distance Learning Tool tools and, in addition, offers CSCW facilities.	Int	√+				
LUVIT	Educators are free to choose their own pedagogical method of delivery and use four fundamental elements: Create, Manage, Run and Evaluate with full flexibility. It offers the normal Distance Learning Tool functionality.	Int	√				
PathLore	It offers a range of services including hosting, content management, strategic planning, implementation, consulting, training off-the-shelf content, authoring tools, virtual classroom technologies and a repository that stores a library of re-usable learning objects. It offers the normal Distance Learning Tool functionality plus some CSCW functionality.	Int	√+				
Serf	It is a Web-based distance education environment that allows the creation and delivery of courses in a self-paced multimedia-learning environment. Its databases keep track of users, maintain states between interactions, deliver courses, and monitor student progress. The databases also include calendars, syllabi, assignments, grades, rosters, and styles. It offers the normal Distance Learning Tool functionality.	Int	√				
TeacherUniverse	It provides development courses for teachers by integrating technology into the curriculum and classroom experience for K-12 students. It does not offer the full functionality of most Distance Learning Tools.	Int	√p				
The Learning Manager	It has been developed over 25 years to support the education and training marketplace. It is used to provide courses (learning materials and tests) that can be delivered in the classroom or at a distance, over the Internet or an intranet, monitor and manage learner progress, communicate with learners 24/7. It offers the normal Distance Learning Tool functionality.	Int	√				
TopClass (WBTsystems)	It is a complete "out-of-the-box" web-based training solution. It provides a Learning Content Management System for web-based delivery, and management of content, a Learning Management System, and stand-alone or offline delivery and content migration and authoring. It offers the normal Distance Learning Tool functionality.	Int	√				
Web Mentor (Avilar)	Avilar started in 1997. It provides web-based competency management and learning solutions for the corporate, government and academic sectors. Its WebMentor® (1998) offers an e-Learning courseware suite to develop, manage and present course materials and assessment tools. It offers the normal Distance Learning Tool functionality.	Int	√				
WebCourseBuilder	It is an easy authoring tool with courses created in HTML and JavaScript that can use the Internet, intranet, extranet, LAN, or CD-ROM. It can be integrated with Distance Learning Tool.	Int	√p				
WebCT	WebCT provides a highly flexible e-learning environment Internet for online teaching and learning and Web-enabled student services. It offers the normal Distance Learning Tool functionality.	Int	√				
XanEdu	Provides the tools tutors and students need to do research, access course materials and significantly reduce the amount of time spent finding what they need. It offers a set of research tools from which course data can be built.	Int	rd				

Symbols & Columns	Detail
√	Yes
√+	Yes PLUS Computer Supported Cooperative Work (CSCW) functionality
√p	Partial
rd	Research/development tool
space	None noted
Int	Deliverable by the Internet, Intranet or Extranet
DL	see Distance Learning Tool table for model functionality
inTS	Intuitive Interactive Tutorial System
CP	Communication Preference (Visual-Auditory-Kinaesthetic) assessment
LS	Learning Styles based on personality types assessment

Figure 3 - Reviewed Distance Learning Tools – model details and notes

Of all the DLT researched none uses any *'Intuitive Interaction'*. Many tools offer training packages for administrators and authors in order for them to become proficient.

The tools reviewed provided excellent administration front-end facilities; however, with many the actual installation and preparation is not easy and requires the ongoing services of a computer technician and administrator.

No Distance Learning Tool reviewed recognizes a student's psychology or dynamically models the student's profile or offers any acknowledgement of the student's communication preference or learning styles (with reference to their personality types) at inception.

2.4 Intelligent Tutoring Systems

ITS originated in the Artificial Intelligence (AI) movement of the late 1950's and early 1960's with researchers like Alan Turing, Marvin Minsky, John McCarthy and Allen Newell who thought that *computers that could "think" as humans do were just around the corner* (Urban-Lurain, 1999).

(T. Murray, 1999) postulates that while ITS, also called Knowledge Based Tutors, are becoming more common and proving to be increasingly effective, each one must still be built from scratch at a significant cost. Domain independent tools for authoring all aspects of ITS, the domain model, the teaching strategies, the student model, and the learning environment, have been developed. They go beyond traditional computer based instruction in trying to build models of subject matter expertise, instructional expertise, and/or diagnostic expertise. They can be powerful and effective learning environments; however, they are very expensive in time and cost, and difficult to build. This means that few ITS exist that can be evaluated and generalization is difficult.

To launch effective systems requires paradigm shift from a 'story-boarding' to a 'data based' paradigm for authoring. Fundamental to this shift is the separation of database content from instructional methods. Authors currently are required to

- Represent their knowledge explicitly and modularly, as opposed to simply authoring what the student will see and enumerating the possible paths that the student can take.
- To create explicit representations of the content and the instructional strategy.

There is a major hold-up to AI work and the creation of computational models of instructional design theories. This is particularly acute in ITS that incorporate rule-based representations of subject matter expertise (T. Murray, 1999).

Most computer tools and techniques that are used in intelligent interfaces stem from the AI field. There are two main areas that come into play:

1. System user modelling, adaptable or self-adaptive. An adaptable program lets the user select how the system should adapt, and a self-adaptive adapts autonomously, by deducing the user's needs from his or her interactions with the system.
2. Natural Language dialogue. Natural Language Programming has been a major area of research in AI ever since the early 1960s; however, the difficulty in parsing unrestricted student input has not yet been satisfactorily solved. Natural Language input in an unfamiliar sentence construction causes problems (Wær, 1997).

(Boy, 1991) affirms that, whilst humans are capable of induction and handle imprecise data easily, computers are almost exclusively deductive systems and can only handle precise data well. Designing Intelligent Assistant Systems has five major stages:

1. Discussing what is known
2. Describing the languages for expressing this knowledge on a computer
3. Determining which treatment processes are going to guide the program from getting from the initial facts to the conclusions
4. Programming the first version of the assistance system
5. Evaluating the intelligent assistant system in an incremental way.

Choosing Good Representation involves considering: Transparency[6], Conceptualization[7], Programming Efficiency[8], Combinatorial Problems[9], Modularity[10], Declarative/procedural balance[11], Implicit/explicit balance[12], Scope of

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[6] **Transparency** is the ability to: edit and verify the knowledge to be developed, write the code and refine the corresponding program, communicate the contents to other people and convince them that the program satisfies the stated requirements

[7] **Conceptualisation** is the way in which the problem and its solution are modelled. The concern here is to establish an isomorphism between that which is wished to be represent and that which has been effectively represented.

[8] **Programming efficiency** consists of minimizing the amount of memory and the running time

[9] **A combinatorial problem** arises when the representation chosen generates an infinite (or very large) number of subtasks to be calculated

[10] **Modularity** is the ability to change parts of the knowledge without having to change all the rest.

the representation[13], Concepts of Imprecision, Uncertainty and Incompleteness, Granularity and Generalization.

(Ryan et al., 2000) expects that ITS will develop so that instruction becomes more individualized and more conversationally informed. Intelligent agents will converse with users, will get to know the student, get to know what the student wants to learn and build a profile of the user's interests.

(Schulze et al., 2000) report that working on homework assignments without the benefit of expert feedback is often a frustrating experience and that this can be alleviated by using an ITS that is capable of providing immediate feedback and relevant hints to students as per *Andes.*[14]

(Lamberti & Wallace, 1990) in their research report that the study provides findings that are discussed within the context of intelligent interface requirements for organizational information systems. The results show that high skill users perform significantly faster and more accurately when solving the problems and have self-reported confidence ratings that are higher than those of low-skill users. The expert system, however, has a greater impact on improving performance for low-skill users than for high-skill users. A relationship is found between skill level and task uncertainty indicating that different skill level users require different presentation formats paralleling their conceptual representations of the problem. The interaction between skill level and knowledge organization is confirmed with results showing that low-skill users perform faster than high-skill users on questions requiring concrete knowledge organization; whereas high-skill users perform better when presented with questions requiring abstract knowledge organization.

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[11] **A declarative/procedural balance** is documenting where the data and programs are stored/held

[12] **The implicit/explicit balance** is the capability of being able to differentiate very clearly between what is to be stored in memory and what is to be calculated.

[13] **The scope** of a representation is the usable limits of the domain of knowledge.

[14] **Andes** is a coached learning environment for classical physics that has been in development since 1996 by researchers at the Learning Research and Development Centre of the University of Pittsburgh and at the United States Naval Academy.

(Alevan et al., 1999) state that *cognitive tutors*[15] have been shown to be effective in raising students' test scores, both in laboratory studies and in actual classroom use. Their research shows that students, using cognitive tutors and explaining their solution steps, have better post-test scores and are better at providing reasons for their answers.

(Aimeur et al., 2001) reports that several experiments have shown that students learn more when they explain their examples to teachers, and further that the use of a 'trouble-maker'[16] in a system must be clearly identified so that the student maintains confidence in the tutor. The student must be able to identify when the 'trouble-maker' is interjecting. The role of the troublemaker is to unsettle the student by proposing solutions that are sometimes true but other times false thereby testing the student's self-confidence and obliging the student to defend his/her point of view. Conflicts are necessary for the student's evolution: they provoke changes in his/her attitudes and performance.

(Urban-Lurain, 1999) considers that ITS must model the student's current knowledge and support the transition to a new knowledge state and that this requires that the system should alternate between diagnostic and didactic support. The student model has three tasks:

1. Gather either explicit or implicit data from and about the student.
2. Use that data to create a representation of the student's knowledge and learning process to enable the system to predict what type of response the student will make in subsequent situations, compare that prediction to the student's actual response, and use that information to refine the model of the student.
3. Account for the data by performing some type of diagnosis, both of the state of the student's knowledge and in terms of selecting optimal pedagogical strategies for presenting subsequent domain information to the student.

---

[15] **Cognitive Tutors** concentrate on developing cognitive strategies. Marc Kaltenbach (Kaltenbach, 2001) classifies human knowledge into 5 capabilities: 1) Intelligent Skills, 2) Verbal Information, 3) Cognitive Strategies, 4) Attitudes, 5) Motor Skills, each requiring a different teaching strategy.

[16] **The trouble-maker** is an agent introduced to an ITS where its level of competence is superior to that of the student in order to provide reasonable competition. It has pedagogical knowledge that can help it to plan its interactions efficiently (Aimeur et al., 2001).

A main problem is "noisy data": a student does not always respond consistently, particularly when his/her knowledge is flimsy and the correct responses are in doubt. (Urban-Lurain, 1999)

2.4.1 Overview of listed Intelligent Tutoring Systems

This section briefly overviews the various listed ITS. All the ITS figures in this section have been constructed from the research literature quoted for each model. The research looked at the type of model used. The research also looked for and reports on the inclusion of Intelligent Intuitive Tutoring System functionality and whether or not the system included the pre-assessment of the student's Communication Preference and Learning Styles (with reference to their personality types).

2.4.2 ADELE - Bayesian Network Model - Animated Avatar (2000)

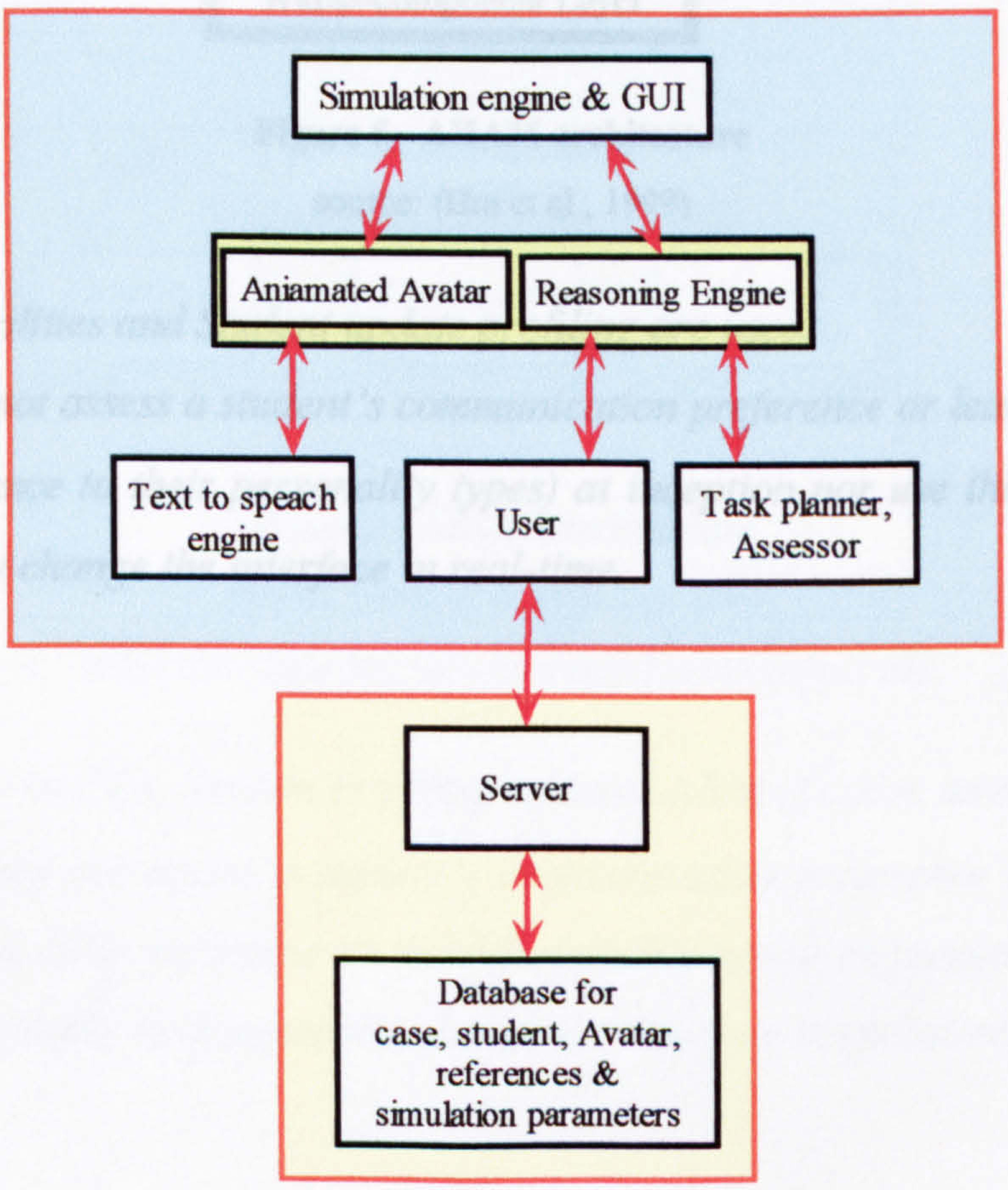

Figure 4 - ADELE architecture

source: (Shaw et al., 2000)

1. *Web-based (not a full DLT), updates Student Profile, Adele provides motivational feedback.*

2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.3 AHAM - Natural Language system (1999)

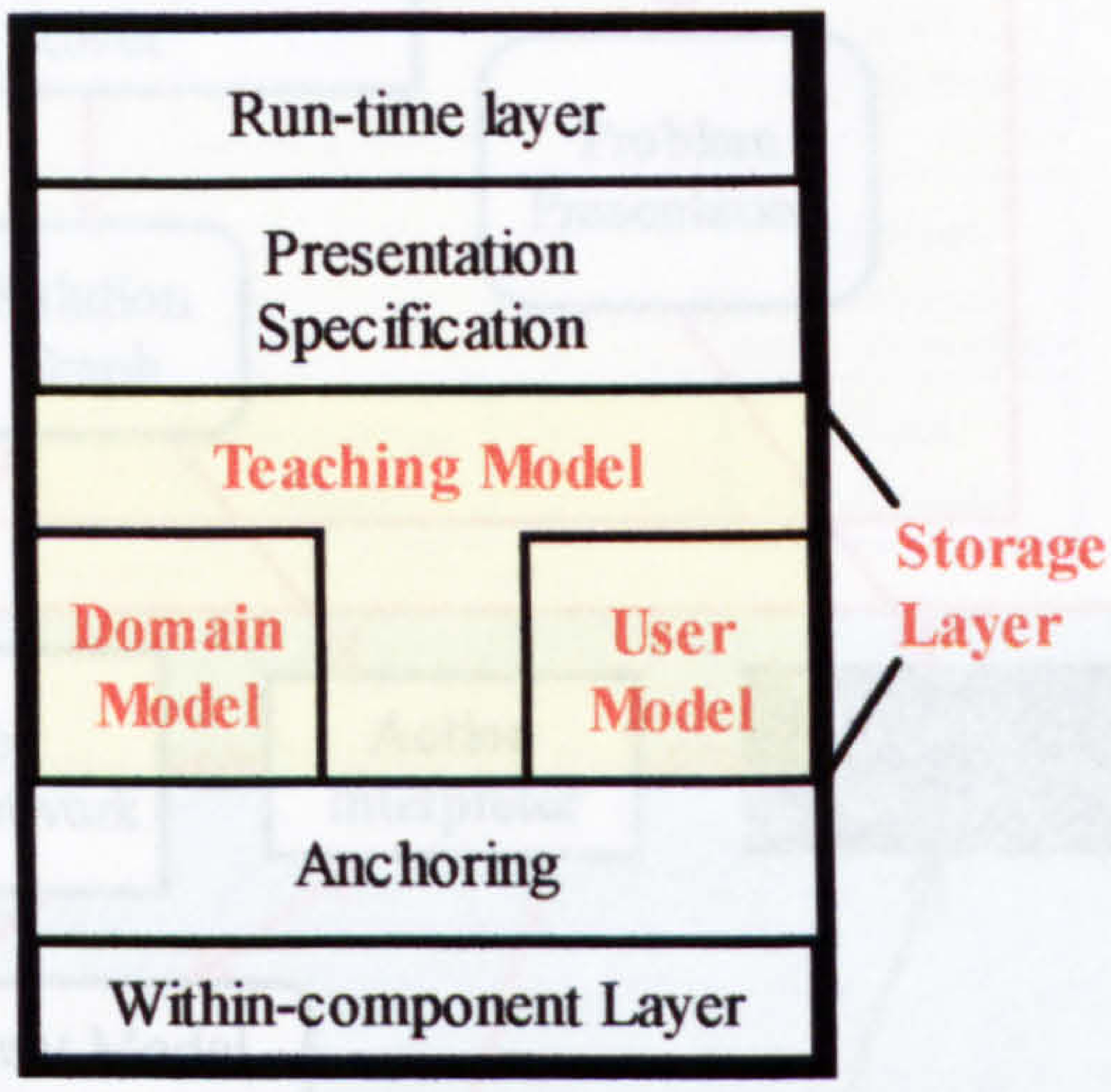

Figure 5 - AHAM architecture

source: (Bra et al., 1999)

1. *DTL facilities and Student update profiling are used.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.4 ANDES - AI, special purpose -Physics & maths (1995)

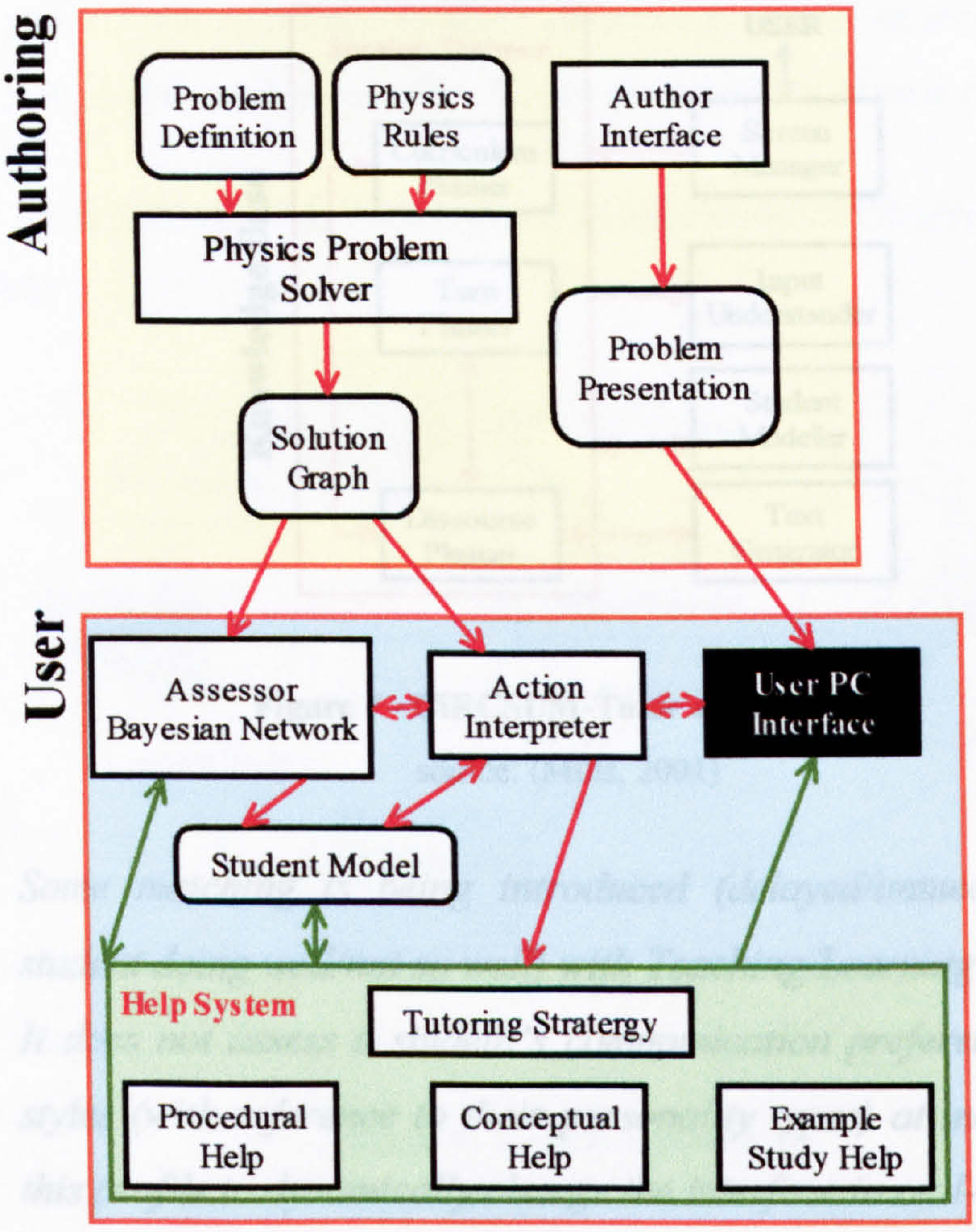

Figure 6 - ANDES architecture

source: (Gertner & VanLehn, 2000)

http://www.pitt.edu/~vanlehn/distrib/Papers/gertner.pdf

1. *Runs on PCs, Student Profiling updated. Most effective initial students.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.5 CiRCSUM-Tutor - Natural Language (1999)

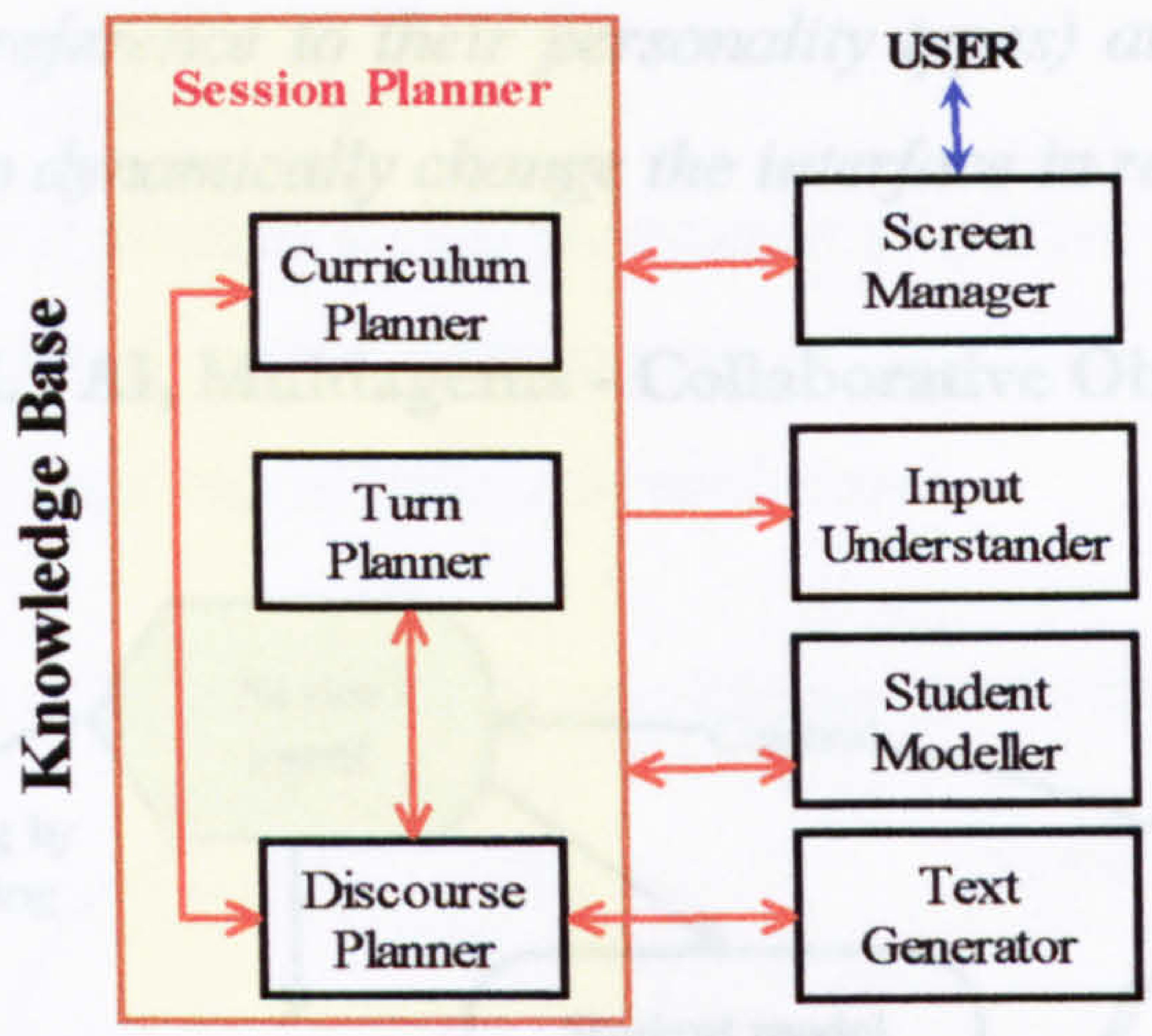

Figure 7 - CiRCSUM-Tutor architecture

source: (Mills, 2001)

1. *Some matching is being introduced (delayed/immediate feedback: student doing well/not so well) with Teaching/Learning styles.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.6 CREAM - AI, Natural Language, Multiple Knowledge (1996)

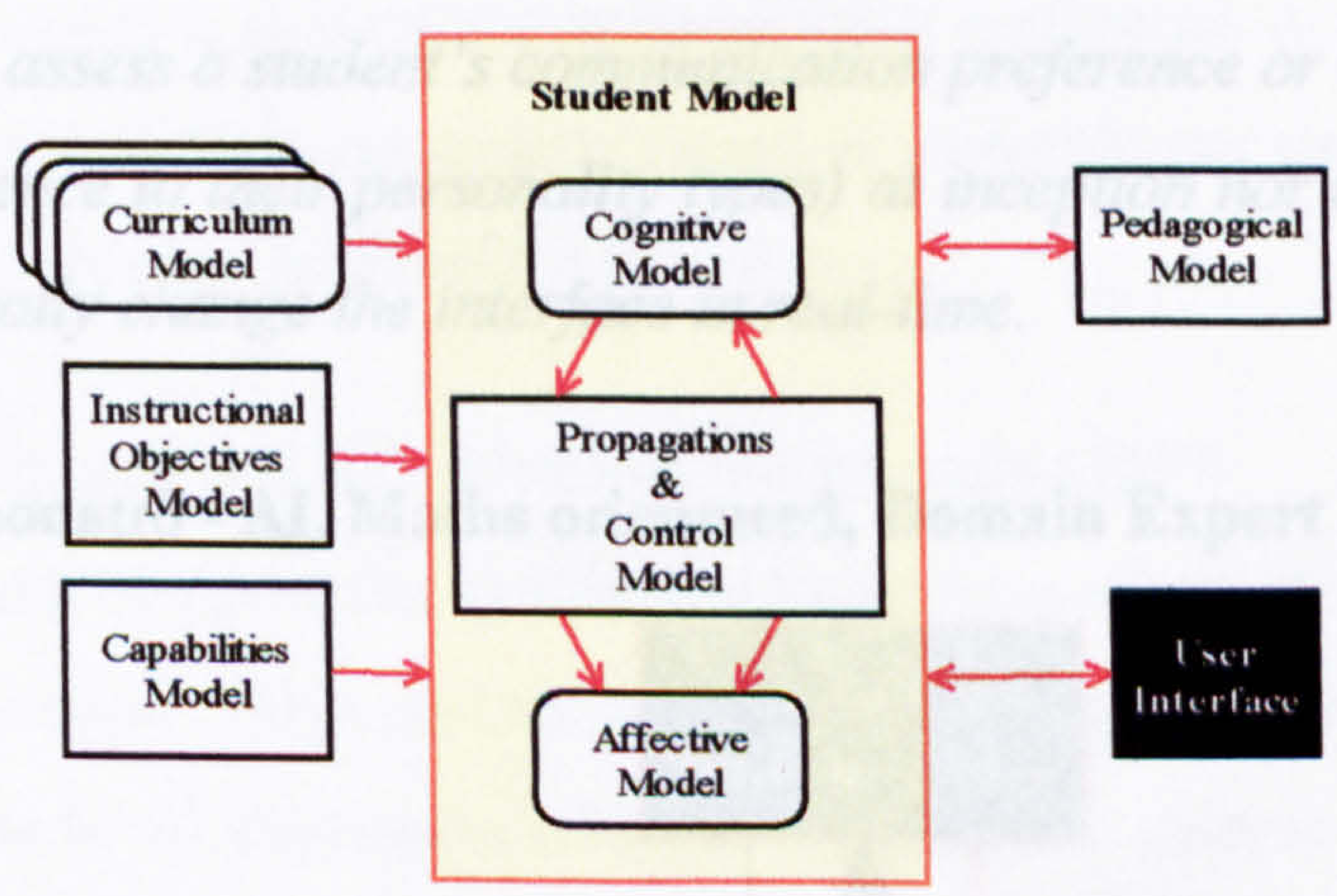

Figure 8 - CREAM architecture

source: (Nkambou et al., 1996)

1. *Student Profile is initialized with student stating what he/she already knows.*

2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.7 CRYSTAL - AI, Multiagents - Collaborative Observation Learning (2000)

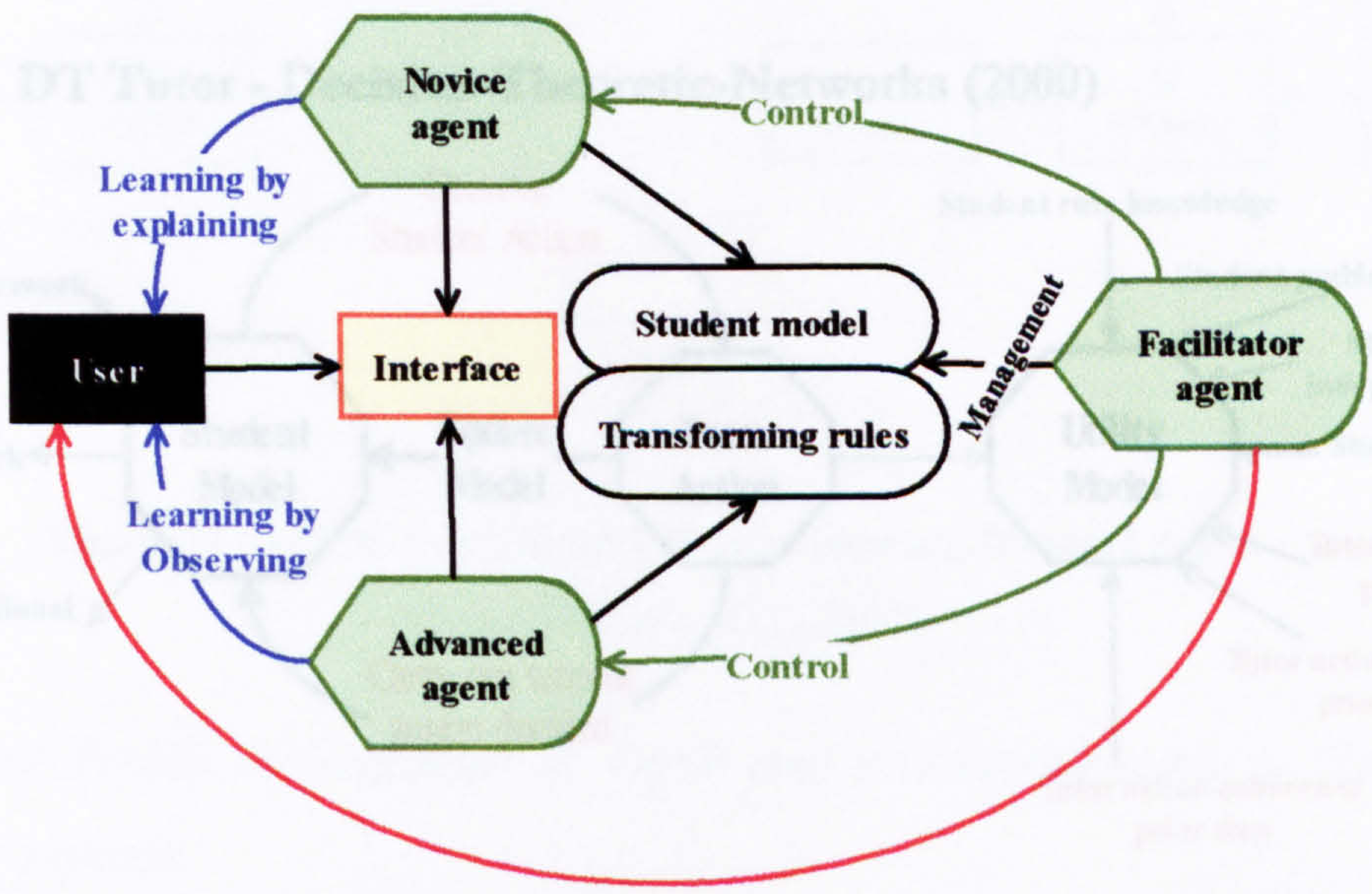

Figure 9 - Crystal architecture
source: (Aimeur et al., 2001; Okamoto & Kasai, 2000)

1. *Student Profile is initialized at logon.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.8 Demonstr8 - AI, Maths orientated, Domain Expert System (1997)

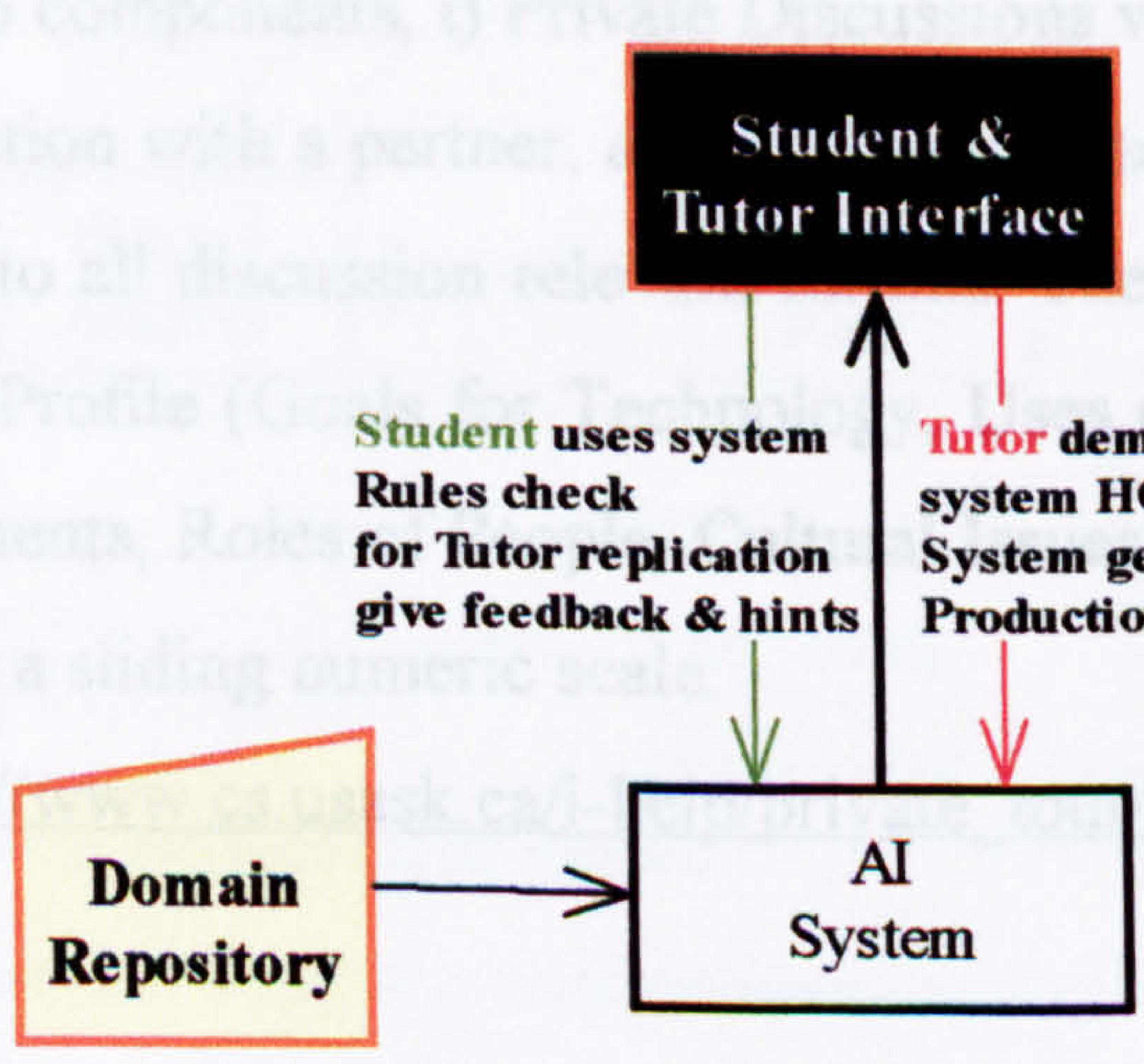

Figure 10 - Demonstr8 architecture

source: (Blessing, 1997; T. Murray, 1999)

1. *Student Profile is initialized at logon.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.9 DT Tutor - Decision-Theoretic-Networks (2000)

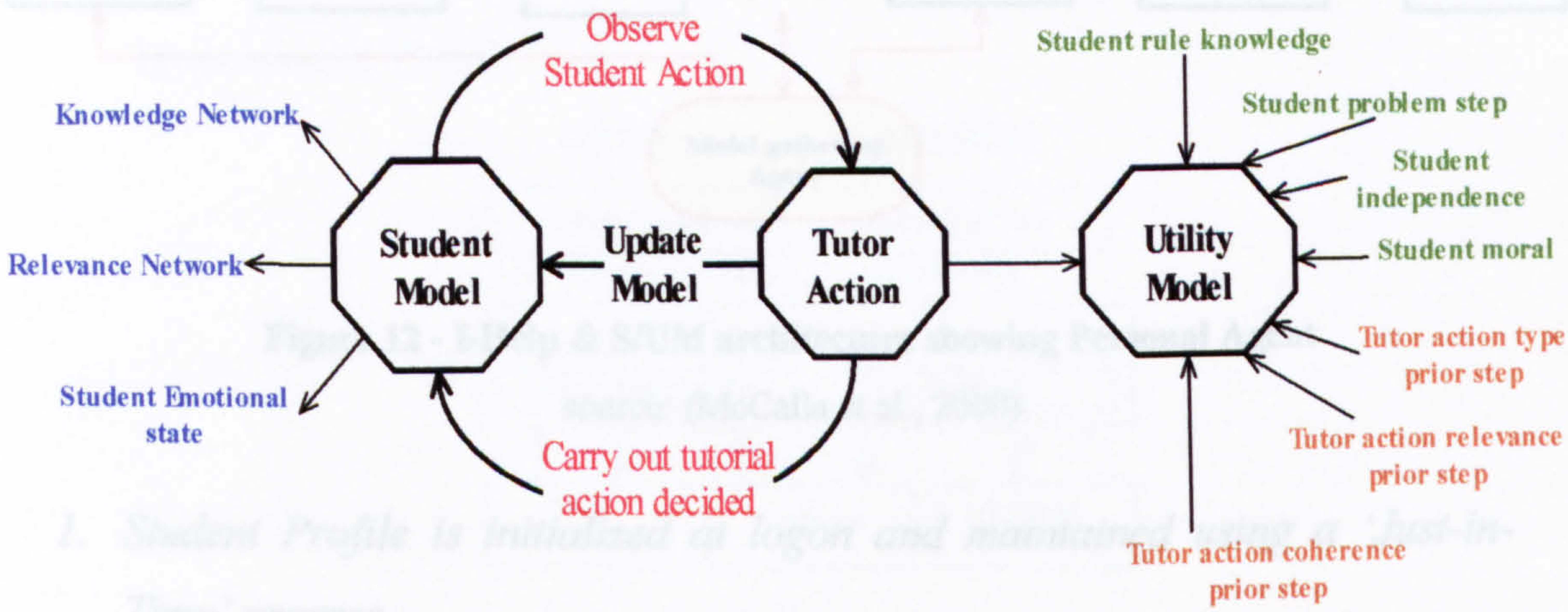

Figure 11 - DT Tutor architecture

source: (R. C. Murray & VanLehn, 2000)

1. *This tool is still in development and Student Profile is initialized at logon.*
2. It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.

2.4.10 I-Help and S/UM - Multi-agent systems (2000)

There are two I-Help components, i) Private Discussions where the users takes part in a one-on-one interaction with a partner, and ii) Public Discussions where everyone in a course has access to all discussion relevant forums. The student can change his/her agent's Knowledge Profile (Goals for Technology, Uses of Technology in Learning, Authoring Environments, Roles of People, Cultural Issues, and Examples of Learning Technologies) using a sliding numeric scale.

(Source: http://www.cs.usask.ca/i-help/private_tour/private_tour.html)

2.4.10.1 S/UM

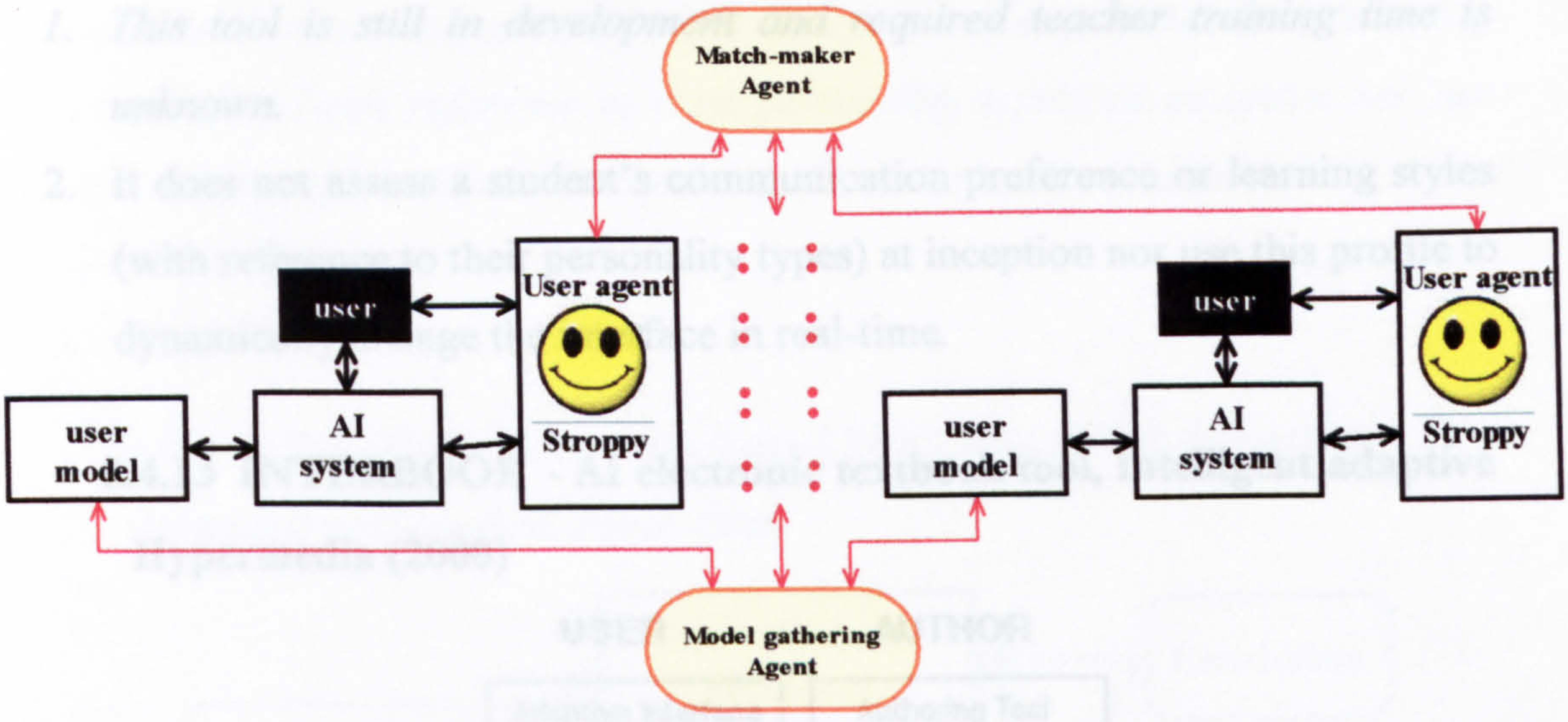

Figure 12 - I-Help & S/UM architecture showing Personal Agent

source: (McCalla et al., 2000)

1. *Student Profile is initialized at logon and maintained using a 'Just-in-Time' process.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.11 IMITS - Interactive Multimedia ITS (2000)

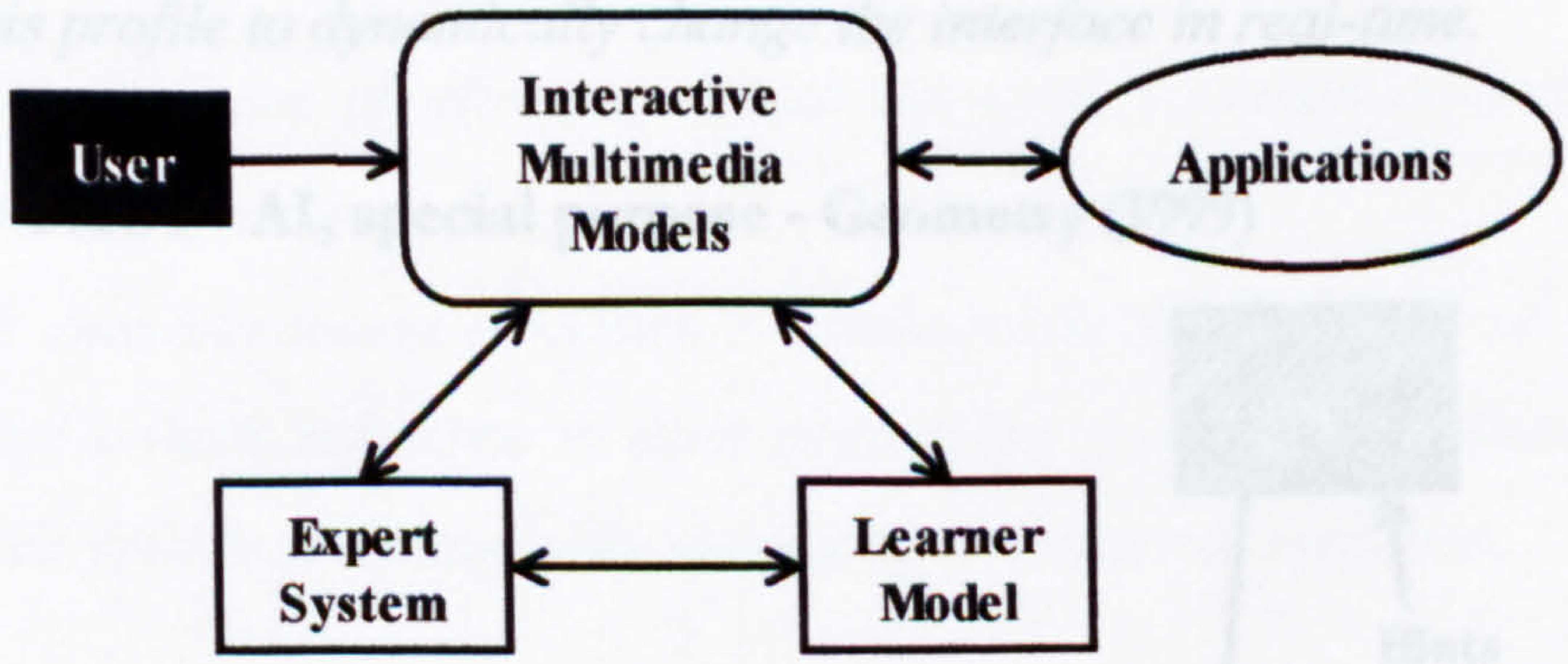

Figure 13 - IMITS architecture

source: (Butz, 2000)

1. *Student Profile is initialized at logon.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.12 IRIS/IRIS-Tutor - AI semantic net, Multiple Knowledge (1997)

1. *This tool is still in development and required teacher training time is unknown.*
2. It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.

2.4.13 INTERBOOK - AI electronic textbook tool, Intelligent/adaptive Hypermedia (2000)

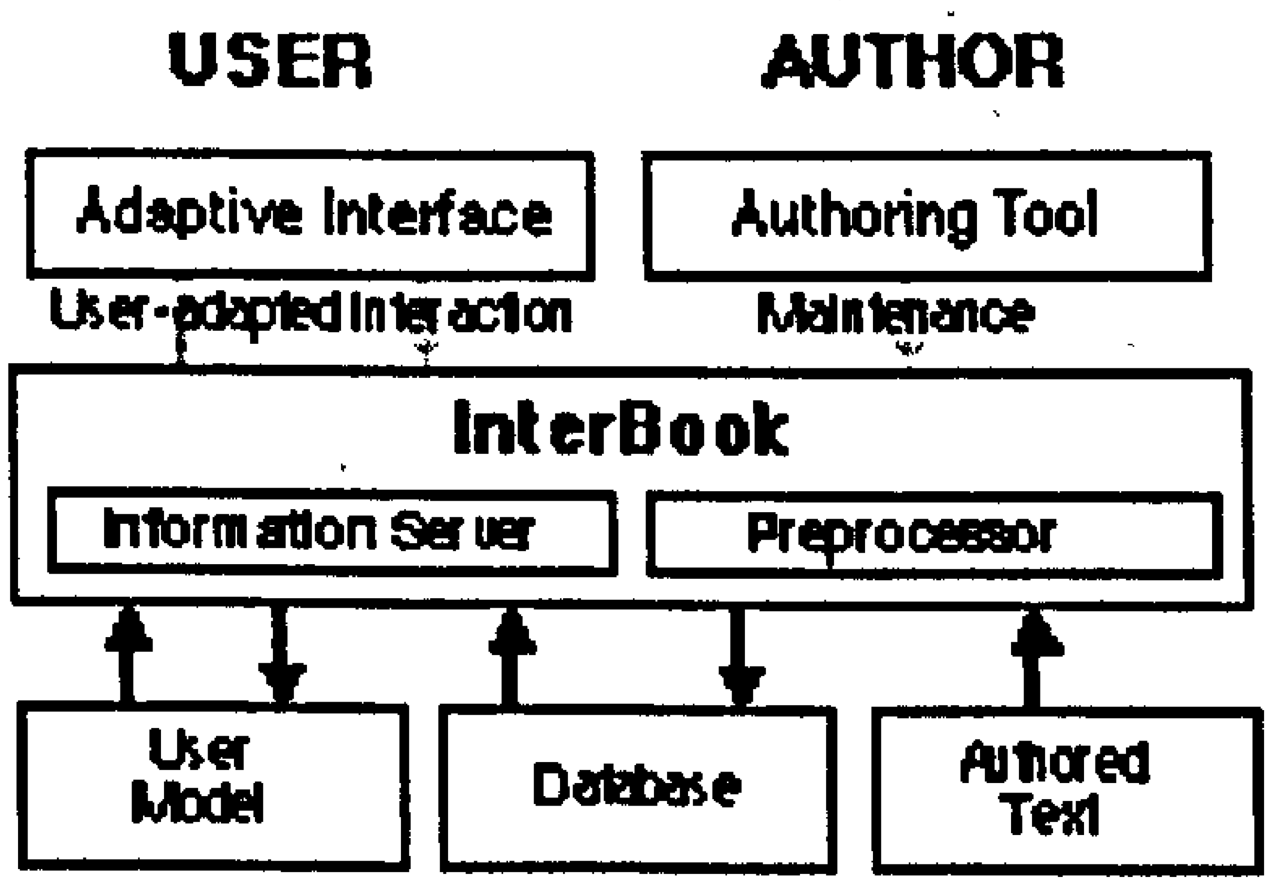

Figure 14 - Interbook architecture

source: (Brusilovsky et al., 1997)

1. *This is a commercial tool and the Student Profile is initialized at logon.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.14 PACT - AI, special purpose - Geometry (1999)

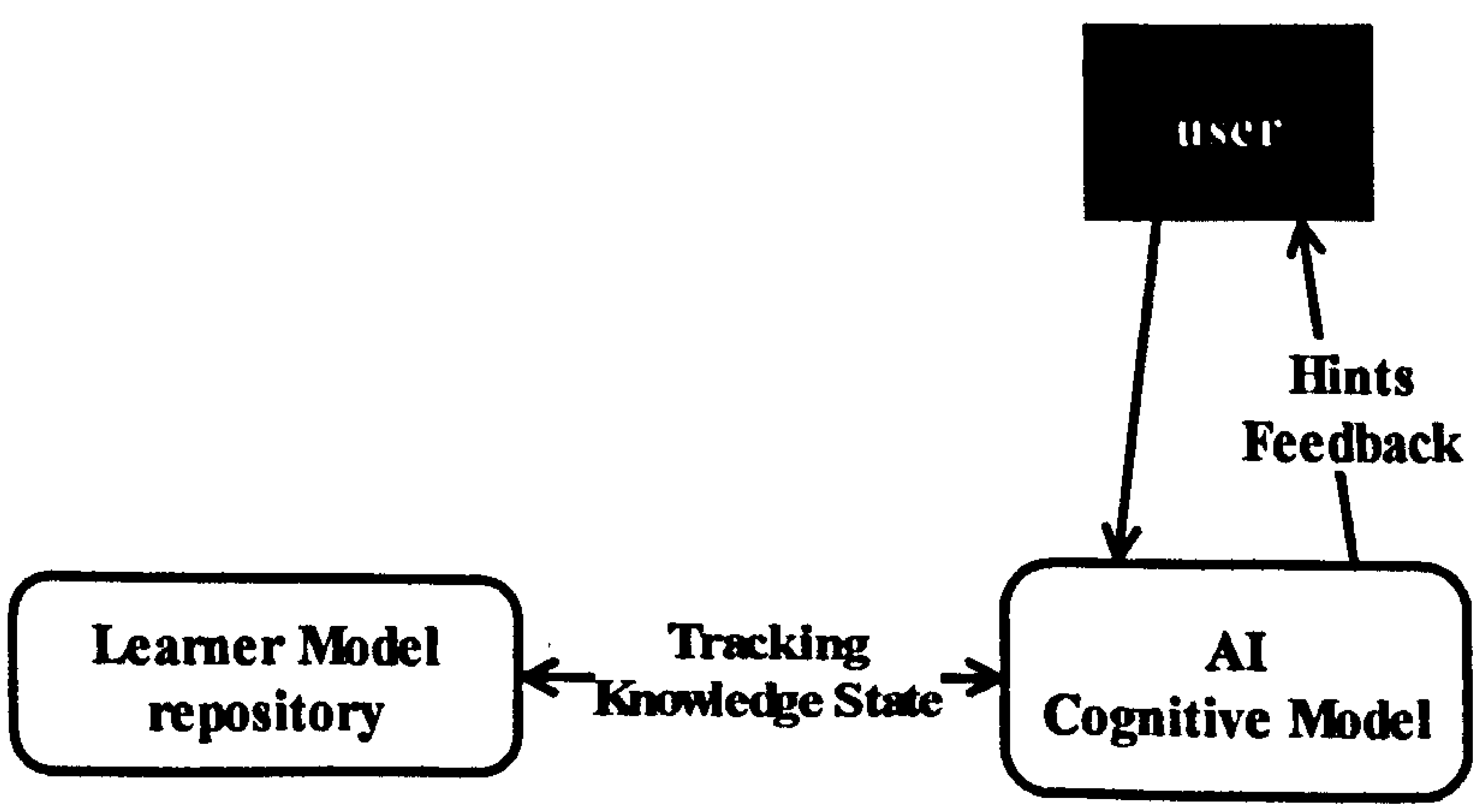

Figure 15 - PACT architecture

source: (Alevan et al., 1999)

1. *Student Profile is initialized at logon*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.15 SQLT-Web - Constraint-based Modelling ITS & SmartEgg - ITS animated pedagogical agent (2000)

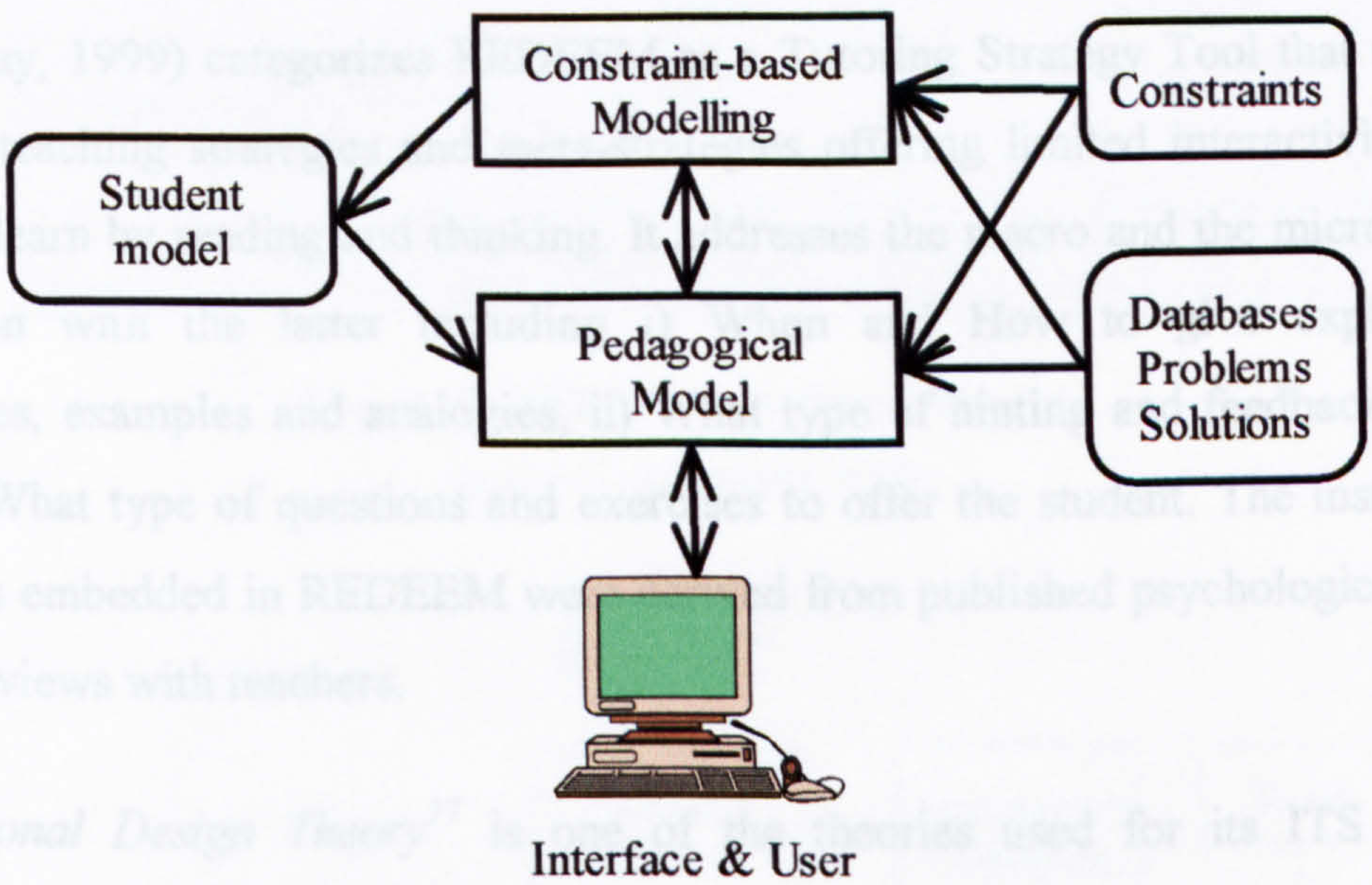

Figure 16 - SQL-Tutor architecture
source: (Mitrovic & Suraweera, 2000)

1. *Development of effective Avatar eye-gaze (communication) is still being researched.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.16 REDEEM - AI constraint based, Tutoring Strategies (1995)

REDEEM is an application whose purpose is to allow teachers and instructors, with little technological knowledge, create simple ITS from existing Computer Based Training (CBT). To meet this goal it provides authors with the following tools: Course Description Tool, Student categorization tool, Teaching strategy editor, Student strategy association tool and Teaching strategy refinement tool. It uses 3 main pieces of software, courseware catalogues, Authoring Tools, Intelligent Tutoring System Shell. It contains a sophisticated rule-based instructional strategy that the author can influence through the use of strategy parameters, but otherwise cannot alter. It also includes an agenda mechanism that keeps track of incomplete authoring tasks and prompts the user to complete them. It is acknowledged to be difficult to use (S. Ainsworth, 2000; S. Ainsworth et al., 2002; S. Ainsworth et al., 1999; S. E. Ainsworth et al., 1999; S. E. Ainsworth et al., 2001; Major et al., 1997; T. Murray, 1999).

(T. Murray, 1999) categorizes REDEEM as a Tutoring Strategy Tool that represent multiple teaching strategies and meta-strategies offering limited interactivity where students learn by reading and thinking. It addresses the macro and the micro level of instruction with the latter including i) When and How to give explanations, summaries, examples and analogies, ii) What type of hinting and feedback to give, and iii) What type of questions and exercises to offer the student. The instructional strategies embedded in REDEEM were derived from published psychological studies and interviews with teachers.

Instructional Design Theory[17] is one of the theories used for its ITS Teaching Strategies, it focuses on learning basic types of knowledge (e.g. facts, procedures, concepts and principles) and concentrates on 'How to Teach'. It is argued that this is crucial to enable teachers to achieve their specific objectives.

Interestingly research has shown that different teachers use different teaching strategies for the same student, thus allowing teachers to adopt their own preferences and teaching theories produce: for the same student, a different path and selection through the course material. It was found that there were strong inter-author differences in what was taught as well as in the order in which it is taught (S. Ainsworth, 2000)

[17] **Instructional-design theory** is a theory that offers explicit guidance on how to better help people learn and develop. The concepts of learn and develop may include cognitive, emotional, social, physical, and spiritual.
(http://www.personal.psu.edu/faculty/s/j/sjm256/portfolio/kbase/Theories&Models/theoryintro.html#idtheory)

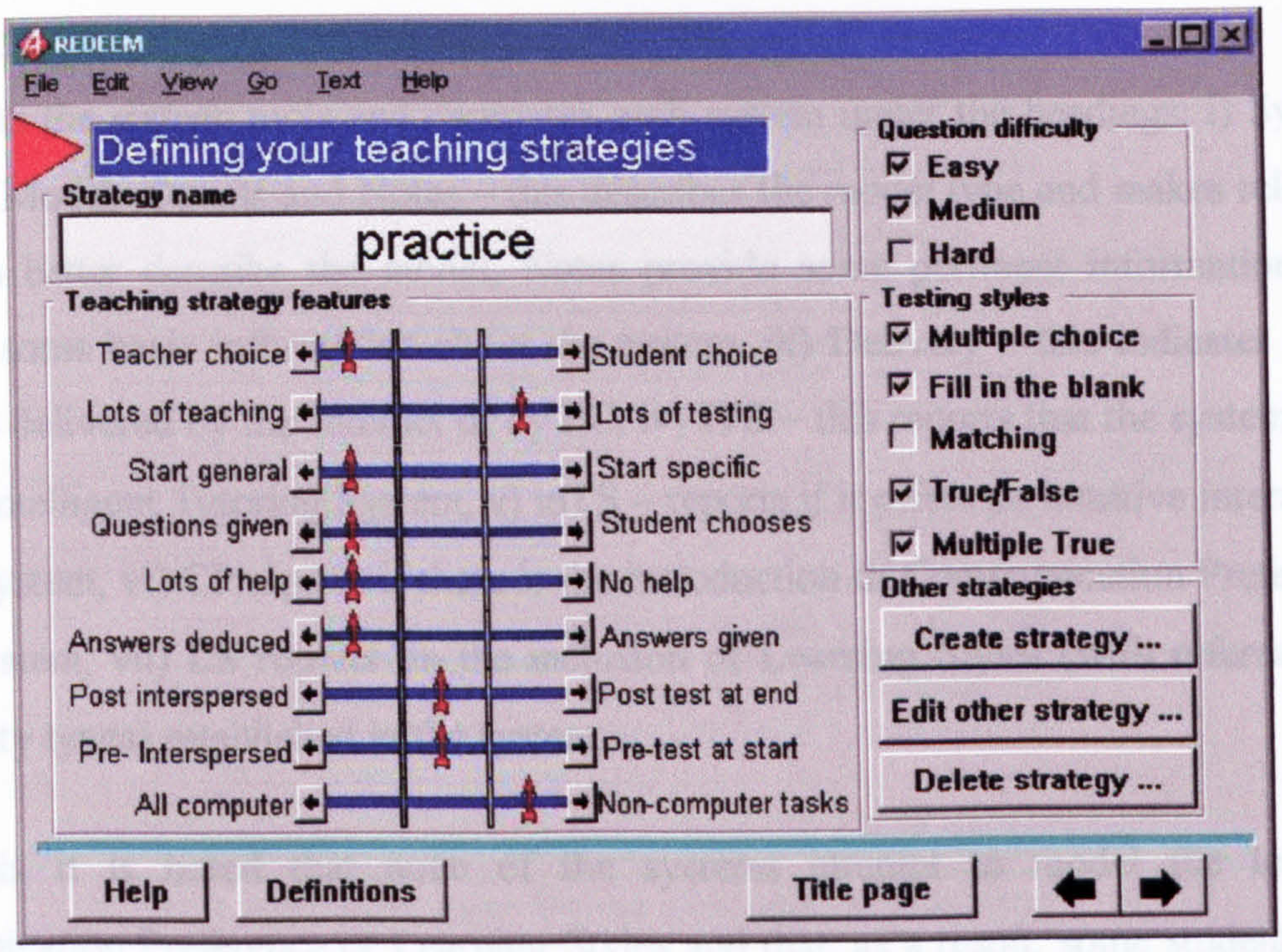

Figure 17 - REDEEM's Strategy front-end

source (S. Ainsworth, 2000)

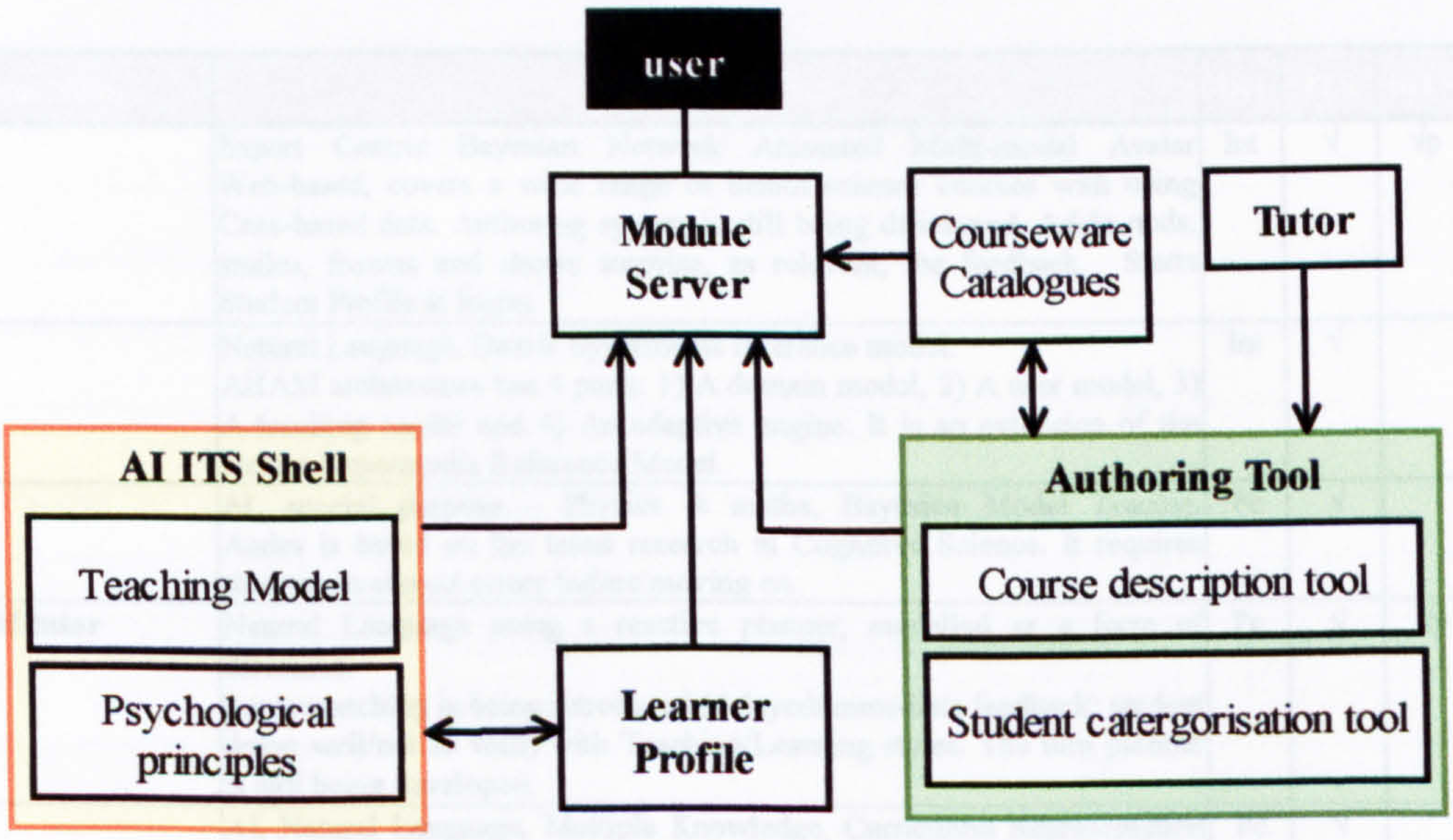

Figure 18 - REDEEM architecture

source (S. Ainsworth, 2000)

1. *Teachers individualize modules to the teaching style they consider relevant for each individual student or student group.*
2. *It does not assess a student's communication preference or learning styles (with reference to their personality types) at inception nor use this profile to dynamically change the interface in real-time.*

2.4.17 Intelligent Tutoring System summary

Fig.19 lists the sixteen tools and compares each system under the headings: i) System name, ii) Models Details and Notes – this describes the model type and makes relevant entries to better describe the model, Notes provide some pertinent information that provides some basic information about the system, iii) Delivery – this indicates if the system is delivered by the Internet or by PC, iv) ITS – this reports that the system is or is not n Intelligent Tutoring System, v) inTS – reports if it offers an intuitive interactive tutorial system, vi) CP reports if there is the introduction of Communication Preference in the system, vii) LS reports on the inclusion of Learning Styles (with reference to personality types) established in the system.

From this it is noted that none of the systems attempt to model the learners Communication Preference or Learning Styles and that, as a result, some students will find the systems of particular interest and very useful, some will cope with them to their best ability and some will find them hard to use.

System Name	Model details & Notes	Del	ITS	inTS	CP	LS
ADELE	Expert Centric Bayesian Network Animated Multi-modal Avatar Web-based, covers a wide range of health science courses with using Case-based data. Authoring system is still being developed. Adele nods, smiles, frowns and shows surprise, as relevant, for feedback. Starts Student Profile at logon.	Int	√	√p		
AHAM	Natural Language, Dexter hypermedia reference model. AHAM architecture has 4 parts: 1) A domain model, 2) A user model, 3) A teaching model and 4) An adaptive engine. It is an extension of the Dexter Hypermedia Reference Model.	Int	√			
ANDES	AI, special purpose – Physics & maths, Bayesian Model Tracing. Andes is based on the latest research in Cognitive Science. It requires students to correct errors before moving on.	Pc	√			
CiRCSUM tutor	Natural Language using a reactive planner, modelled as a form of discourse. Some matching is being introduced (delayed/immediate feedback: student doing well/not so well) with Teaching/Learning styles. The turn planner is still being developed.	Pc	√	√p		
CREAM	AI, Natural Language, Multiple Knowledge, Curriculum Representation & Acquisition Model. Initially the learner provides the system with details of information already known - this provides the initial student model.	Pc	√			
Crystal	AI, Multiagents - Collaborative Observation Learning. Uses 3 situated agents (Novice, Advanced & Facilitator). Starts Student Profile at logon.	Pc	√			
Demonstr8	AI, Maths orientated, Domain Expert System, Analogy-based AI techniques to generalize from specific to the general solution. Uses an overlay student models that predicts and simulates student behaviour. Tutor uses same interface as learner to create tutorial, system creates production rules.	Pc	√			
DT Tutor	Decision-Theoretic-Networks. This tool is still in development. It uses decision-theoretic methods to select tutorial actions.		√			
I/Help	Multi-agent. Uses the model 'involve the learner the diagnosing process' to learn. Starts Student Profile at logon.	Int	√			
IMITS	AI, Interactive Multimedia Intelligent Tutoring - multi-modal model. This system is designed to use Macromedia's Authorware 5. Student model is created at logon with almost every move being tracked.	Int	√			

Interbook	AI electronic textbook tool, Intelligent/adaptive Hypermedia. This is a commercial tool for authoring and delivering adaptive electronic textbooks on the World Wide Web. The user model is the main component of InterBook's open architecture. It stores the student's current state of knowledge and uses an extended overlay model that is suitable for any educational domain. It cannot track a student's state of knowledge during problem solving. It tracks the student's conceptual knowledge.	Int	√			
IRIS/IRIS-Tutor	AI semantic network, Multiple Knowledge, Pedagogy oriented domain modelling, uses a semantic network of topics of three levels: Cognitive processes, Instructional events and Instructional actions. This tool is still in development and required teacher training time is unknown. Classified as pedagogy oriented domain modelling it assists tutors to create teaching style modules.	Pc	√	√p		
PACT	AI, special purpose - Geometry. The PACT Geometry Tutor is a cognitive tutor for high-school geometry problem solving.	Pc	√			
REDEEM	AI constraint based, Tutoring Strategies, Meta-data. It contains a sophisticated rule-based instructional strategy that the author can influence with strategy parameters.This ITS allows teachers to individualize modules to the teaching style they consider relevant for each individual learner or learner group. Student is updated using an overlay model.	Pc	√	√p		√p
S/UM	Multi-agent. Uses the model 'involve the learner the diagnosing process' to learn. Starts Student Profile at logon. Its architecture uses a 'matchmaker agent' and a 'model gatherer agent'. Each user maintains their own user model and contributes to numerous student peer models using a 'just-in-time' student modelling process.	Int	√			
SQLT-WEB (Smart Egg)	Constraint-based ITS - Avatar ITS pedagogical agent. An intelligent web/Solaris/MS Windows tutor for the SQL database language. A simple overlay forms the long-term student model. Motivational feedback incorporated in SmartEgg.	Int	√	√p		

Symbol	Detail
√	Yes
√+	Yes PLUS Computer Supported Cooperative Work functionality
√p	Partial
Rd	Research/development tool
Space	None noted
Int or Pc	Delivery by: Int=Internet, Pc=Personal Computer
DL	Distance Learning Tool
InTS	Intuitive Interactive Tutorial System
CP	Communication Preference (Visual-Auditory-Kinaesthetic) assessment
LS	Learning Styles based on personality types assessment

Figure 19 - Reviewed Intelligent Tutoring Systems – model details and notes

ITS are normally built for a specific purpose with student-modeling being developed from the interaction between the student and the system without the student communication preference or student styles being pre-determined using student psychometric data.

REDEEM allows Teacher Style preference to be selected but this is only matched with the student/s by a subjective decision made by the tutor of each individual student/student group and NOT by the system, and, as shown by research (William A.

Janvier & Ghaoui, 2003b; Wilson et al., 2002) introverts tend to hide their dominant personality and are often misunderstood by their tutors.

2.5 Chapter Summary

The DLT review looked at the content offered in:

- *A module* - Syllabus, Search, Course notes & materials, Tasks, Library.
- *Communication tools* - Forum, Email, Chat, Whiteboard, Announcements
- *Assessment tools* - Quizzes, Surveys, Self-tests, Assessment tools
- *The model details & notes*
- *System delivery*
- *The totality of the Distance Learning package*
- *The Intuitive Interactive content* of the model
- *The way Communication Preference* was established and used
- *The way Learning Styles* (with reference to personality types) was established and used

Of the reviewed tools:

- The standard module content was offered by 87%
- The standard communication tools were offered by 83%
- The standard assessment tools were offered by 89%.

In particular it was noted that there is a move to offer functionality for Computer Supported Cooperative Work (CSCW) evidenced by the commercial tools. The requirement by industry for intercommunication held simultaneously with many participants in different parts of the world is driving the development of many tools. This is starting to be mirrored in e-education with CSCW facilities being used by different institutions.

All of the tools reviewed were designed to enable Internet/Intranet/Extranet delivery. The tools that did not offer the full DLT package tended to concentrate on ease of authorship with the facility to upload the completed material to the main e-distance learning tools (e.g. Blackboard). XanEdu, in particular, has specialized in generating a tool and facilities for research to enable the tutor/faculty to produce their own books and students to be able to research in depth.

No Distance Learning Tool reviewed recognizes a student's psychology or dynamically models the student's profile or offers any acknowledgement of the student's communication preference or learning styles (with reference to their personality types) at inception.

The ITS review looked at the content offered in:

- *The model details & notes*
- *System delivery*
- *The totality of the Distance Learning package*
- *The Intuitive Interactive content* of the model
- *The way Communication Preference* was established and used
- *The way Learning Styles* (with reference to personality types) was established and used.

Whilst all the tools are Intelligent Tutoring Systems, their use of AI varies - models use: AI Avatars, Bayesian Model Tracing, Decision-Theoretic-Networks, Expert Centric Bayesian Network, Intelligent/adaptive Hypermedia, Multiagents and Natural Language.

Of the systems reviewed:

- 44% offered full Internet functionality.
- 50% were PC based.
- 31% offered partial intuitive intelligent interaction: these displayed feedback via:
    - An Avatar that changes its body-language relevant to the current situation
    - Matched teaching/learning style requirement from perceived interaction
    - Provided motivational feedback.
- Only one, REDEEM, attempted to establish the student's learning style at inception, this being based on the subjective view of the tutor - there is no attempt to establish the LS scientifically.

At the current time authoring systems can be loosely defined as either commercial systems or AI research tools. The former, like Authorware, ToolBook, have a number of advantages over the AI research tools:

- Help in lesson planning
- Built-in widgets making instructional presentation easier
- A large amount of course material has already been built using them.

The latter, like REDEEM, have all the adaptive behaviour that ITS developers have programmed and come with the following:

Advantages

- A knowledge base structure and interpreter like an expert system shell.

Disadvantages

- Usually restricted to specific domains
- Problems of offering the student a facility that matches his/her learning and/or communication style
- Problems with tutors time to learn system.

No ITS assesses a student's communication preference or learning styles (with reference to their personality types) at inception scientifically using psychometric tests nor use this profile to dynamically change the interface in real-time.

These Literary Reviews highlights the gap that exists that WISDeM starts to cover:
Research indicates that creating a Student's Profile from his/her Communication Preference and Learning Styles (with reference to personality types) and using this profile to dynamically change the user interface has not been offered in any DLT or ITS.

CHAPTER 3

COMMUNICATION PREFERENCE

AND

LEARNING STYLES

3 Communication Preference & Learning Styles

This chapter introduces:

- Communication Preference (CP): discusses CP and its relevance to learning and remembering. Neurolinguistic Programming (NLP): covers the part that NLP plays in inter-personnel communication and introduces NLP eye-gaze and language patterns.
- Learning Styles (LS): discusses the pros and cons of learning styles, covers the Dunn & Dunn Learning style model, Kolb's Learning Style inventory, the Myers-Briggs Type Indicator® (MBTI®) - personality type designation – its reliability and validity, the VARK Learning Style Preferences, Maslow's Motivational Hierarchy of Needs, Gagne's Hierarchy of Learning,
- Summary: introduces the important elements from this chapter that have been encapsulated in the WISDeM system.

3.1 Communication Preference

Communication Preference *relates to the way a person prefers to take in and output information, it is the selection of your own way in the art and technique of using words effectively to impart information or ideas*[18]. Everyone has their own particular preferential technique/s to exchange ideas with others, acquire knowledge and pass knowledge to a third party (Bandler, 1985; Chen et al., 2004; Coffield, Mosley et al., 2004; C Ghaoui & Janvier, 2004a; Honey & Mumford, 1986; Skinner, 2003).

Over 50% of Human-Human Interaction (HHI) is conveyed by body language[19], over 33% by tone of voice and only a small part is conveyed by the words themselves; thus, it is not what is said that is important but the way that it is said and the accompanying body-language that is used. Almost all this input, this learning is external to the body being introduced by one of the five senses (touch, sight, taste, hearing and smell).

[18] The thesis concentrates on three preference: visual, auditory and kinaesthetic.

[19] **Body Language** is the conscious or unconscious bodily movements and gestures that communicate to others a person's attitudes and feelings. This includes dress, facial features, skin colour or other personal means of communication without words (Beattie, 2003; Pease, 1997).

Whilst the input is noted by the sensual memory, the actual remembered item[20] may not be a true representation of the actuality due to the fact that it has been exposed to interpretation as perceived by the recipient's 'inner voice, eye, ear, nose and taste': the input has been filtered, interpreted and assessed against previous remembered input, beliefs and concepts. Non-essential knowledge is filtered and only remembered if the individual considers it important or interesting enough to remember (Brown, 2001; Catania, 1992; Cotton, 1995).

A prime part of remembering is memory rehearsal with Working Memory constantly improving and refining Long-term Memory with the recipient gaining more information from input that matches his/her own communication preference (Cotton, 1995; C Ghaoui & Janvier, 2004a; William A. Janvier & Ghaoui, 2003b). Of particular importance is **Iconic Memory**[21] whose input to memory equates to 60% (Cotton, 1995). The time course of iconic memory is measured over fractions of seconds but in this time the subject retains images that no longer are there. Subliminal images and text (instance input that the conscious mind does not observe but the subconscious does) can have a powerful effect on memory and cognitive memory. "*Unconscious words are pouring into awareness where conscious thought is experienced, which could from then on be spoken (the lips) and/or written down*" (Gustavsson, 1994).

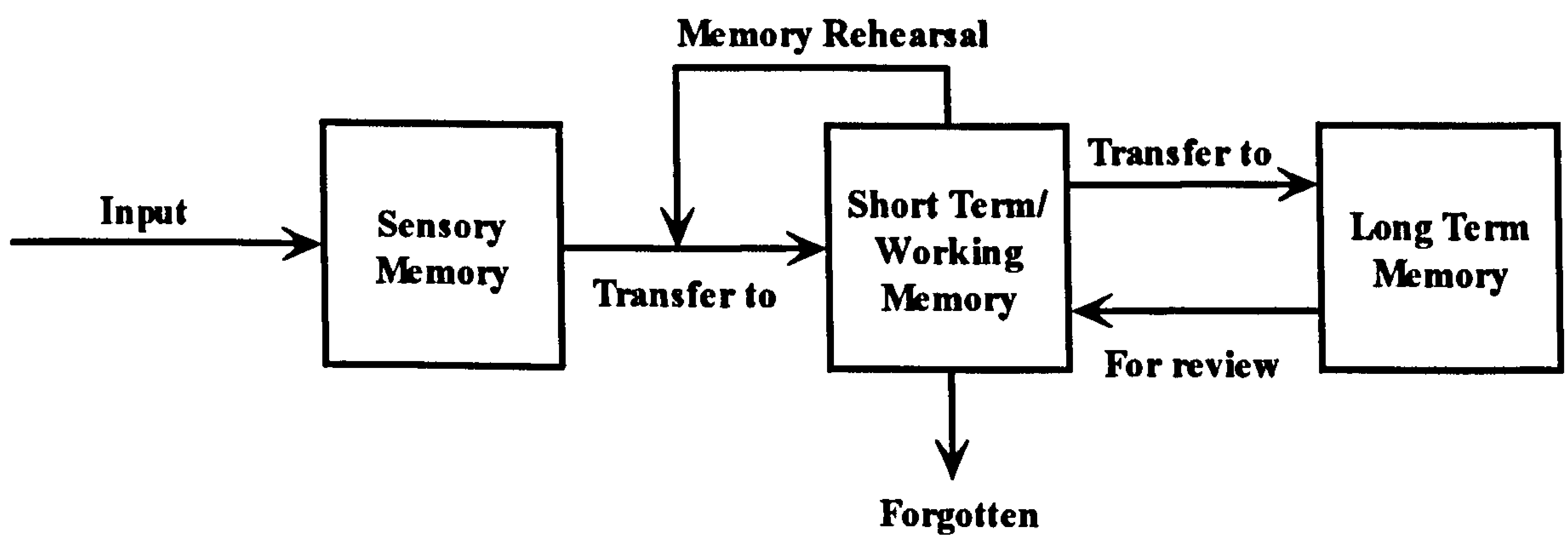

Figure 20 - The flow of sensory input and remembering

[20] **Remembered Item**: a stored, retained and retrieved sensory input (long-term memory).
[21] **Iconic Memory**: the persisting effects of visual stimuli.

3.2 Neurolinguistic Programming

The name Neurolinguistic Programming (NLP) comes from the disciplines that influenced the early development of its field, beginning as an exploration of the relationship between neurology, linguistics, and observable patterns (programs) of behaviour. Combining these disciplines Neurolinguistic Programming can be defined as the reception, via our nervous system, of instances received and processed by the five senses (sight - iconic, hearing – echoic, touch – haptic, taste – gustatory, and smell – olfactory), the resultant use of language and nonverbal communication system through which neural representation are coded, ordered, and given meaning using our ability to organize our communication and neurological systems to achieve specific desired goals and results, or more succinctly "*The Study of the Structure of Subjective Experience and what can be calculated from it*" (William A Janvier & Ghaoui, 2002b; Pasztor, 1998b; Sadowski & Stanney, 1999; Slater et al., 1994).

John Grinder, a Professor at UC Santa Cruz and Richard Bandler, a graduate student, developed NLP In the mid-70s. They were interested in how people influence one another, in the possibility of being able to duplicate the behaviour, and thus the way people could be influenced. They carried out their early research in the University of California at Santa Cruz where they incorporated technology from linguistics and information science, knowledge from behavioural psychology and general systems theory developing their theories on effective communication. As most people use the term today, NLP is a set of models of how communication impacts and is impacted by subjective experience. It is more a collection of tools than any overarching theory. It broadly falls under the heading of cognitive psychology and is very well used for commercial applications, such as sales and marketing. It was developed outside the academic mainstream and today remains largely divorced from mainstream academic psychology. Much of early NLP was based on the work of Virginia Satir, a family therapist; Fritz Perls, founder of Gestalt therapy; Gregory Bateson, anthropologist; and Milton Erickson, hypnotist. - Stever Robbins, NLP Trainer (Bandler & Grinder, 1981)[22].

[22] See Bandler and Grinder's book "Patterns of the Hypnotic Techniques of Milton H. Erickson, Volume I" for further reading (Publisher: Grinder, DeLozier & Associates.; July 1, 1996, ISBN: 1555520529).

The conscious observation of body-langue such as eye-gaze, changing pupil size, eye movement and the use of NLP language patterns play an important part for the skilled communicator (Bandler & Grinder, 1990; Craft, 2001; William A Janvier & Ghaoui, 2002b; Skinner, 2003). Our eyes express our emotions and intentions and they help us direct attention. Social aspects of eye gaze have been mentioned as early as on clay tablets from Mesopotamia. Cultural norms dictate when, for how long and in what situations it is appropriate to gaze into another person's eyes. Psychologists have found high correlations between changes in eye gaze and specific conversational actions (Colburn et al., 2000).

3.2.1 Neurolinguistic Programming - Eye accessing cues

Subliminal communication occurs in any face-to-face communication when the senses, mainly iconic, receive body-language input. In particular the eyes convey a myriad of signals of which "Eye Accessing Cues" are particularly useful.

It is possible to make this eye-movement cognitive by observing the direction in which the eyes are moving during conversation. When eyes move in a certain direction, you can detect if the subject's thinking is visual, auditory or kinaesthetic/emotionally. The movement of the eye is governed by eye-dominance with right-eye dominance signals going to the left cortex and left-eye dominance to the right cortex. Assuming that the subject is right-eye dominant the following pertains:

- *Visual remembered*: (eyes up to the left): Recalling past images.
- *Visual constructed:* (eyes up to the right): Vision conceptualization.
- *Auditory remembered*: (eyes to the left side): Recalling past sounds.
- *Auditory constructed*: (eyes to the right side): Conceptualization.
- *Auditory digital*: (eyes down to the right): Talking to him/herself.
- *Kinaesthetic/Emotion/Feelings*: (Eyes down to the left): Feels emotions, sense of touch or muscle movement (Pasztor, 1997, 1998b; Sadowski & Stanney, 1999).

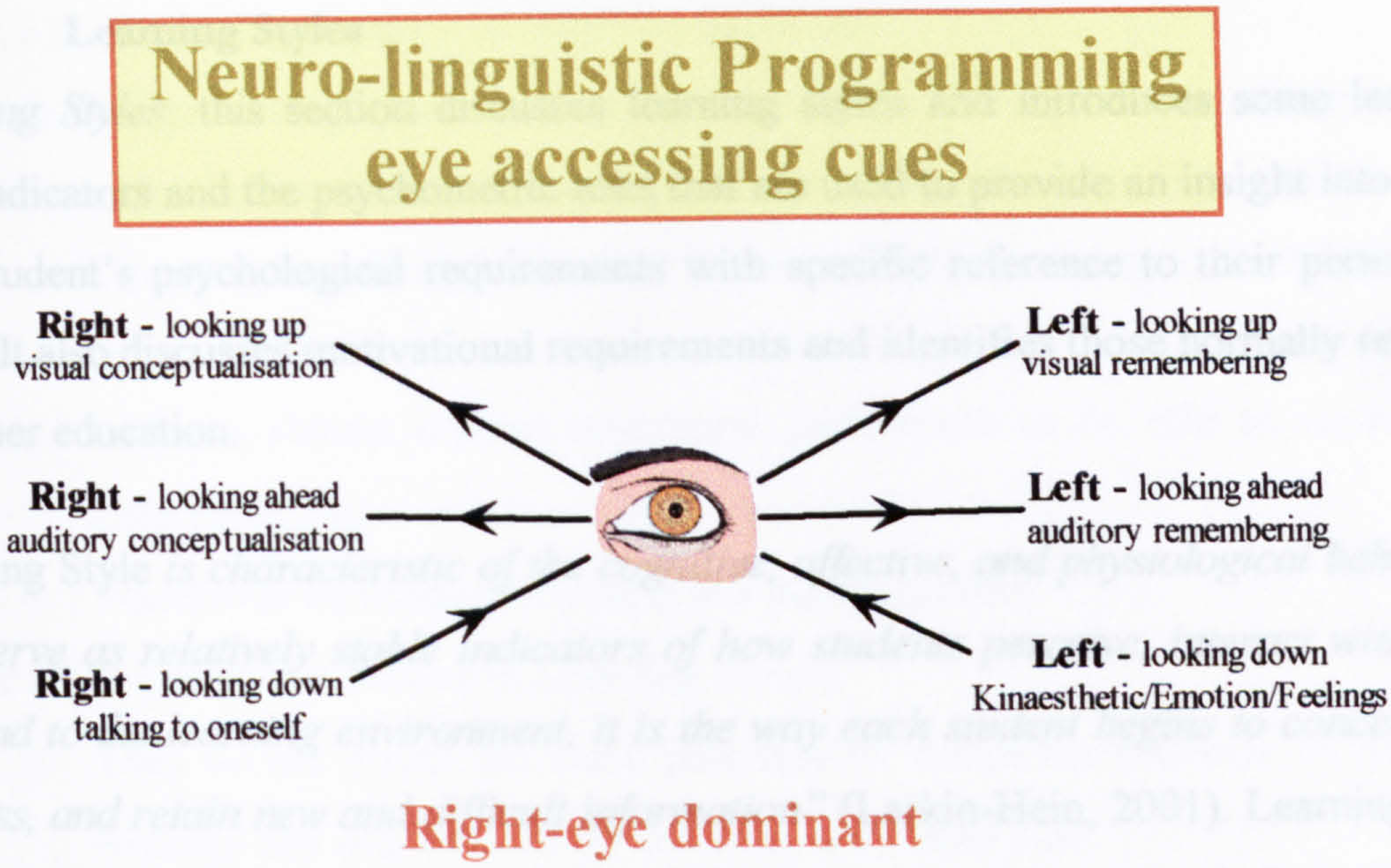

Figure 21 - NLP eye accessing cues

3.2.2 Neurolinguistic Programming Language Patterns

(Pasztor, 1998a) quotes the example of a student with a Visual NLP style whose tutorial learning strategy was based on "listen, self-talk" and sport-learning strategy was "listen, picture, self-talk", the former did not achieve memory store/recall whilst the latter did. (Pasztor, 1998a) reports that rapport with a partner is the key to effective communication and that incorporating NLP in intelligent agents will allow customization of the personal assistant to the particular habits and interests of the user thus making the user more comfortable with the system. Introducing the correct sub-modality (visual, auditory, kinaesthetic) will enable the subject to more easily store and recall instances in/from memory. It is argued that inviting a subject to "see" invokes iconic, to "hear" invokes auditory and to "feel" invokes kinaesthetic recall (Pasztor, 1997).

3.2.3 Communication Preference and NLP Summary

Communication Preference is about the way an individual's remembering works and is based on his/her memory. Role rehearsal (memory rehearsal) tends to store an instance in long-term memory. This is later recalled, as required, into Working Memory.

Neurolinguistic Programming involves the conscious use of how HHI operates, the observation of body language, eye-movement and eye-gaze and how it is possible to affect HHI by using the correct language patterns.

3.3 Learning Styles

Learning Styles: this section discusses learning styles and introduces some learning style indicators and the psychometric tests that are used to provide an insight into some of a student's psychological requirements with specific reference to their personality types. It also discusses motivational requirements and identifies those normally relevant in higher education.

Learning Style *is characteristic of the cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how students perceive, interact with, and respond to the learning environment, it is the way each student begins to concentrate, process, and retain new and difficult information"* (Larkin-Hein, 2001). Learning style is also... *"a biologically and developmentally imposed set of personal characteristics that make the same teaching (and learning) methods effective for some and ineffective for others*" (Larkin-Hein & Budny, 2000).

3.3.1 Introduction

In this section the rationale for using Learning Styles and a variety of models are discussed:

- *The Dunn and Dunn Model* – selected to illustrate learning styles and preferences that are largely constitutionally based and include the three modalities: Visual, Auditory, Kinaesthetic)
- *The Learning Style Inventory (David Kolb Model) learning cycle* – selected to illustrate learning styles that are flexibly stable learning preferences
- *The Myers-Briggs Type Indicator (MBTI) personality type designation* – selected to illustrate learning styles as one component of a relatively stable personality type
- *The VARK (Visual, Auditory, Read/Write, Kinesthetic) tool learning preferences* – selected to illustrate learning styles and preferences are largely constitutionally based and include the three modalities: Visual, Auditory, and Kinaesthetic.
- *Maslow's Motivational Hierarchy of Needs* – selected to illustrate motivational requirements in learning
- *Gagne's Hierarchy of Learning* – selected to illustrate the differing hierarchy of learning.

3.3.2 Learning Styles – is their use justified?

There is a difference of opinion with regard to the value of using Learning Styles:

- For those that believe that Learning Styles help learners to remember:
  a. Learners should identify their learning styles/preferences/modalities and focus on them,
  b. Learners should attempt to expand preferences to be able to incorporate different styles,
  c. Traditional methods of teaching fail many students.
- For those that do not believe in Learning Styles:
  a. They do not accept the basic premises on which the research, its theories, findings and implications for teaching have been built.
  b. They consider that because 'measurements' are derived from the students' own subjective judgment that this undermines the validity of the findings.
  c. They state that respondents are encouraged to give the first answer that occurs to them - the first response may not be the most accurate.

(Coffield, Moseley et al., 2004)

As has been shown in Communication Preference each learner has their own particular communication preference and personality types; these can be viewed as either strengths or weaknesses according to the composition of the teaching delivery. In considering learning styles, cognisance is taken of the fact that different personality types require different communication treatment. The extrovert reacts to HHI in a different manner to the introvert, the former is more friendly and the latter more cold or reserved. In HHI the measured personality type takes more time and likes to be specific, whereas the quick personality type likes to 'get-things-over-and done-with' and reacts quickly (Fuller et al., 2000; William A. Janvier & Ghaoui, 2003b; Myers & Myers, 1995).

Consideration is also given to the thesis assumption that Carl Jung theory is correct in that people have a basic personality type encapsulated by the time they reach their late teens and that over a period of time they have learnt to use secondary, tertiary, etc. functions to show the world what they want the world to see. It is accepted that both this and a contrary view may be the subject of anecdotal or empirical evaluation. Either evaluation approach is subject to criticism when investigating the validity of specifying personality types:

- Evaluation by other than the individual under investigation is open to the evaluator's own interpretation, observation, subjectivity and preconceptions,
- Evaluation that relies on measurement of self-reporting is open to the way the subject interprets the evaluation matter and what he/she wants the world to see. If a subject has a basic introvert-personality and considers that their best interest lies with the world seeing an extrovert-personality, will the evaluation reflect the true state?

There are underlying problems with learning style theories/instruments is that:

- Evidence for the reliability and validity of learning style instruments is weak since there are very few robust studies,
- The theories are generated from differing disciplines (psychology, sociology, education and policy studies) and are subjective in nature,
- Some models have an extremely influential commercial following with little support reported empirical research (Coffield, Moseley et al., 2004).

Much research has demonstrated that students have preferred learning styles that directly impact their ability to assimilate and retain course content (Borchert et al., 1999; Driscoll & Garcia, 2000). Whilst subjects gain their knowledge mainly by Iconic input (60%, 30% Echoic, 10% Haptic (Catania, 1992)), (Driscoll & Garcia, 2000)'s research showed that Students preferred a kinaesthetic (hands-on) mode, either by itself or in combination with other learning styles (multi-modal).

One of the basic concepts of this thesis is that HCI should replicate HHI as far as possible and that the main interaction in HHI is the inter-communication that is derived from body language. Communication Preference and Personality Types play a major part in this interaction and that, therefore, the inclusion of Communication Preference and Learning Styles, where the latter is based on personality types, in HCI will enhance communication, understanding and, thus, remembering. These, CP and LS, lay alongside any other pedagogical Learning Style that assists the student to learn.

3.3.3 The Dunn and Dunn Learning Style Model of Instruction

The Dunn and Dunn Learning Style Model has been developed, since1976, by Professors Rita and Kenneth Dunn. It uses a diagnostic teaching framework and is based on the theory that individual students learn best in different ways and that a student's individual learning preferences or styles must be accommodated if the student is to given the best opportunity to learn. To do this, the student's learning style must be assessed (see Fig.22) (Larkin-Hein, 2001; Larkin-Hein & Budny, 2000; NCDEP, 2001).

(NCDEP, 2001) report that the Dunn and Dunn Model utilizes two basic learning theories - *cognitive style*[23] and *brain lateralization*[24] with the major components of the model being: a) the model's principles, b) the learning style elements, c) the identification of learning styles, and d) the model's impact on the dimensions of the instructional situation. The model involves two main types of activities (identification of individual learning styles, and planning and implementation of instruction to accommodate individual students' learning style strengths) using the following "learning styles elements" (see Fig.22).

One of the most comprehensive instruments to assess the learning/productivity style developed for the Dunn and Dunn Model is the Productivity Environmental Preferences Survey (PEPS) using a 100-item self-report questionnaire. By 1998 research results from 112+ higher education institutions showed positive increases in results for those students whose Dunn and Dunn learning styles had been accommodated (Larkin-Hein & Budny, 2000).

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[23] **Cognitive Style** - Two main dimensions or categories of cognitive style have been identified; *conceptual tempo* and *field dependence-independence*. **Conceptual tempo** refers to a continuum of thinking style from impulsive thinking to reflective thinking that is observed as an individual responds to a variety of situations or learning tasks. **Field dependence-independence**, related to the concept of global-analytic thinking styles - from students who perceive information in a holistic and/or simultaneous manner (global thinkers) to students who perceive information sequentially in independent parts (analytic thinkers) (NCDEP, 2001).

[24] **Brain Lateralization Theory** is based on the idea that the two hemispheres of the brain have different functions: left brain=verbal-sequential abilities and right brain=emotions-spatial holistic processing (NCDEP, 2001).

Environmental Stimuli Preferences	Design Light Sound Temperature
Emotional Stimuli Preferences	Motivation Persistence Conformity/Responsibility Structure from source
Sociological Stimuli Preferences	With an Adult With 1 other individual Peers/Team Working alone Varied
Physiological Stimuli Preferences	Intake Mobility Perceptual *(Iconic, Echoic, Haptic, Kinaesthetic)* Time of day
Psychological Stimuli Preferences	Global/Analytic Right/left Hemisphericity Impulsive/Reflective

Figure 22 - Dunn and Dunn's Learning Style Elements

3.3.4 The Learning Style Inventory (David Kolb Model)

Prof. David A. Kolb developed the 'Learning Style Inventory' in 1976. Active Learning involves the student directly participating in the how too. The Kolb Learning Style Model provides for four cyclical elements: a) *concrete experience* b) *observation and reflection*, c) the *formation of abstract concepts* and d) *testing in new situations* through which students progress.

Whilst it is usual to start at 'Concrete Experience' Kolb argues that learning can start at any stage. Active Learning provides the role rehearsal to enable instances to be stored in long-term memory (Smith, 2001; Sporre, 2001). Each *Learning Style*[25] is incorporated in this cycle with meta-cognitive skills[26] influencing what is learnt.

[25] **Learning Styles** - Activist, Reflector, Theorist and Pragmatist.
[26] **Meta-cognitive skills** - Knowing the way your own mind works.

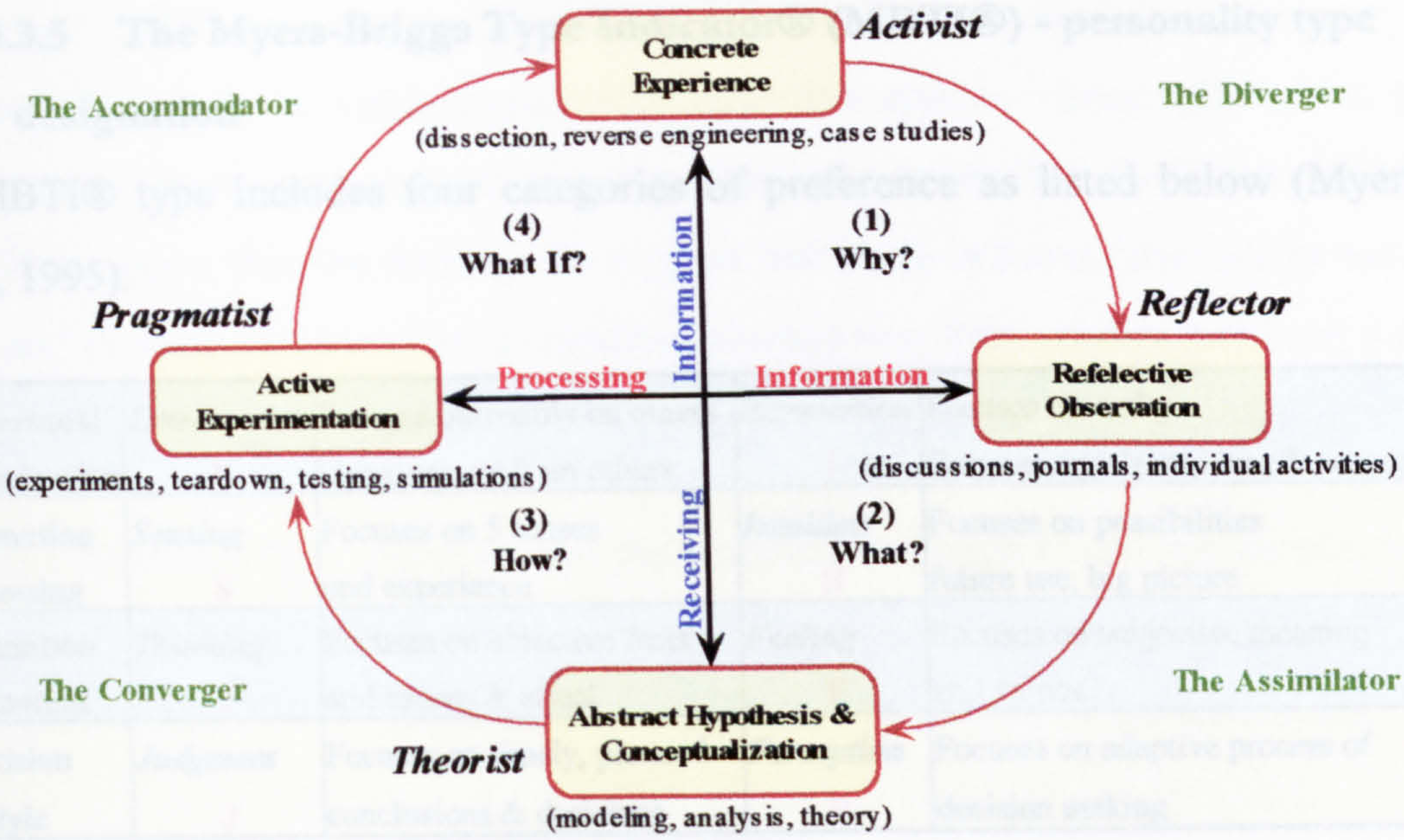

Figure 23 - Prof. D.A. Kolb's experiential learning circle

(Smith, 2001) states that Kolb names four types that provide for the duple "Receiving | Processing" Information:

- **The Diverger**

  Learning Characteristics - Concrete experience + Reflective observation

  Description - strong imaginative ability, interest in people, sees things from different perspectives

- **The Assimilator**

  Learning Characteristics - Abstract conceptualization + Reflective observation

  Description - excels in inductive reasoning, concerned with abstract concepts (not people), ability to create theoretical models

- **The Converger**

  Learning Characteristics - Abstract conceptualization + Active experimentation

  Description - strong in practical application, unemotional, narrow interests

- **The Accommodator**

  Learning Characteristics - Concrete experience + Active experimentation

  Description - A doer, a risk taker, intuitive problem solver, reacts to immediate circumstances well.

3.3.5 The Myers-Briggs Type Indicator® (MBTI®) - personality type designation

The MBTI® type includes four categories of preference as listed below (Myers & Myers, 1995).

Interpersonal Communication	***Extroversion*** E	Focuses outwardly on others Gains energy from others	*Introversion* I	Focuses inwardly Gains energy from ideas & concepts
Information Processing	***Sensing*** S	Focuses on 5 senses and experience	***Intuition*** N	Focuses on possibilities future use, big picture
Information Evaluation	***Thinking*** T	Focuses on objective facts and causes & effect	***Feeling*** F	Focuses on subjective meaning and values
Decision Style	***Judgment*** J	Focuses on timely, planned conclusions & decisions	***Perception*** P	Focuses on adaptive process of decision making

Figure 24 - Myers-Briggs Type Indicator Preference Types

The Information Processing (sensing vs. intuition) category is seen by most researchers to be the most important of the four categories in terms of implications for education (Borchert et al., 1999).

Work on MBTI has included efforts to improve creativity, to aid students in their use of self-paced material and to tailor the learning environment to meet students' differing preferences (Borchert et al., 1999).

(Larkin-Hein & Budny, 2000) consider that whilst extroverts' learning preferences are shown the *"cardinal precaution in dealing with introverts is not to assume that they have revealed what really matters to them"*.

3.3.5.1 MBTI Reliability and Validity

(Tzeng et al., 1984) reports that 444 college students/clerical employees were used as the study group to complete the MBTI psychometric test. The results of the study tended to substantiate that MBTI is a reliable instrument and that the ninety-five marker items in the inventory would generate four distinct psychometric dimensions that are consistent with the theoretical constructs of the MBTI. The major implication of the research is that MBTI can be used with confidence to distinguish separate personality types in terms of the four dichotomous dimensions.

(Schweiger, 1985), reporting on the results of their study, provided only partial support for the MBTI scale as valid measure for cognitive styles – Sensing|iNtuition scale demonstrated greater convergence with hypothesized process than the Thinking|Feeling scale. They report that the findings do suggest that there is some relationship between scales and process; however, the evaluation exercise was only constructed from a small sample and therefore was open to questioning.

In 1992 (Johnson, 1992), reported that the National Research Council criticized MBTI as a self-assessment instrument that is likely "at best, to capture a person's current state of mind." It criticized both the reliability and predictive validity of the instrument.

(Coffield, Moseley et al., 2004) reports that MBTI:

- Provides a view of the whole personality, including learning, but not specifically about learning.
- The reliability coefficients are high for individual pairs of scores relating to each of the scales, but the stability of the sixteen types is less impressive.
- The face validity of the MBTI is generally accepted, but construct validity is controversial because of the debate about whether the constructs are best represented by opposing pairs.

Interestingly they consider that it is still not clear which elements of the sixteen personality types in the MBTI are most relevant for education, whereas (Borchert et al., 1999) report that the Information Processing (sensing vs. intuition) category is seen by most researchers to be the most important of the four categories in terms of implications for education.

(Kakabadse et al., 2004) reports that MBTI has achieved "the most credibility in the literature and empirical research" and that "the instrument has been tested extensively for validity and reliability".

(Briggs/Myers & McCaulley, 1985) report that MBTI attempts to classify persons according to their "true" types (their emphasis) and that when comparing MBTI with Jungian Type survey they both reflect exactly the same things, though with different reliabilities. The report states that to validate MBTI results can be achieved by comparing MBTI results with self-assessment of type preference. This done by chance statistically would expect to pick the correct type once out of sixteen times (6.25% of the time). In an evaluations carried out by Carskadon in 1975 and 1982 with 129 and 118 introductory psychology students the reported type was ranked first more often than by chance for both samples (35% $p<0.001$, and 50% $p<0.001$): both results are highly significant. (Briggs/Myers & McCaulley, 1985)'s report concludes "*The authors concluded that (a) the idea that type descriptions other than one's reported type might be equally appealing had been refuted and (b) their subjects seemed to feel more confidence or certainty in their preferred functions (S, N, T, or F) and/or more flexibility in their attitudes (E, I, J, or P).*"

3.3.6 VARK Learning Style Preferences

A student's VARK descriptor is formed from one or a combination of four different modes of taking in information: Visually (Iconic), Auditory (Echoic), Read/write and Kinaesthetic (see Fig. 25 (N. D. Fleming & Mills, 1998)).

- The Visually (**V**) oriented students prefer to receive information, via their eyes, in charts, graphs, flow charts, and symbolic representation.
- The Aural (**A**) orientated indicates a preference for hearing information.
- The Read/write (**R**) orientated student prefers information displayed as words.

The Kinaesthetic (**K**) orientated student prefers "learning by doing" either learning by simulated or real-world experience and practice (Borchert et al., 1999).

Visual	Create concept maps - Draw diagrams, models, flow charts, etc. - See videos, slides, photographs to explain, clarify or as discussion triggers.
Aural	Use audiotapes - Class debates - Peer discussion (Think-Pair-Share - Small or Large groups) - Brainstorming - Guided lecture - Responsive lecture - Group presentations
Read/Write	One-minute write - Summaries - Case studies - Journals - Formative quizzes - Analytical lists - Round table response
Kinaesthetic	Role-play - Create a physical representation - Use three-dimensional models - Analyze a problem - Positive tutor/peer feedback.

Figure 25 - VARK - Learning Style Preferences

(Driscoll & Garcia, 2000) reports that results obtained for class profiles of students using VARK indicate that student learning styles are firmly in place by the time a student reaches the university and may well differ substantially from what their tutors assume. Their research also shows that the majority of students prefer a multi-modal input mode followed by Kinaesthetic.

3.3.7 Motivational learning – Maslow's Hierarchy of Needs

Motivation has five different defense mechanisms: i) repression[27], ii) projection[28], iii) reaction formation[29], iv) fixation[30] and v) regression[31]. Hence the requirement to ensure that motivation is **positively** reinforced by the use of suitable rewards for the different levels of Maslow's hierarchy of needs (see Fig.26).

Once each level is satisfied motivation moves up a level. Higher-level education motivation normally works at the 'Cognitive Need' level though the 'Esteem Needs' level can play an important part (Cotton, 1995). Motivation in cognitive psychology requires that the student has set a goal and that the learning program takes cognizance of this in its planning and presentation. Unfortunately with cognitive dissonance[32] students who fear failure reject attempts to learn treating success as 'good luck' rather than 'success expectancy' (Cotton, 1995).

Self-actualisation	Realizing one's full potential
Aesthetic Needs	Beauty (in art/nature) - Balance - Order
Cognitive Needs	Knowledge - Understanding - Curiosity
Esteem Needs	Self-esteem - Self-worth - Respect from others
Love & Belongingness	Receiving/giving love & affection
Safty Needs	Protection from danger
Physiological Needs	Food - Drink - Air - Warmth

Figure 26 - Maslow's Hierarchy of Needs

3.3.8 Gagne's Hierarchy of Learning

In 1956 Robert M. Gagné (an American Psychologist) proposed a system of classifying different types of learning in terms of the degree of complexity of the

[27] **Repression** - the desire to prevent unconscious memories becoming conscious
[28] **Projection** - alleviating anxiety and evading responsibility by 'passing the buck'
[29] **Reaction formation** - a defensive mechanism that results in doing unwanted tasks
[30] **Fixation** - protection by not exposing oneself to the unknown by staying at your current state
[31] **Regression** - protection by returning to younger patterns of behaviour
[32] **Cognitive Dissonance** - a mental situation that demands a solution (smoker wants to stop smoking)

mental processes involved. He identified eight basic types, and arranged these in a hierarchy of increasing complexity (Cotton, 1995; Ellington & Earl, 1996; Smith, 2001; Sporre, 2001).

Signal Learning	This is the simplest form of learning. It consists of classical conditioning
Stimulus-response Learning	This uses operant conditioning with the stimulus-response 'rewards' and 'punishments' presented after the response.
Chaining	The subject develops the ability to connect two or more previously-learned stimulus-response bonds into a linked sequence.
Verbal Associations	This is a form of chaining in which the links between the items being connected are verbal in nature.
Discrimination Learning	This involves developing the ability to make different responses to similar stimuli that differ systematically. The process is more complex due to interference whereby one piece of learning inhibits another. Interference is considered 1 main cause of forgetting.
Concept Learning	This involves developing the ability to make a consistent response to different stimuli that form a common class or category of some sort.
Rule Learning	This high-level cognitive process involves being able to learn relationships between concepts and apply these in different situations, including situations not previously encountered.
Problem-solving	The highest level of cognitive process involving developing the ability to invent a complex rule, algorithm or procedure to solve a problem, then use this to solve other similar problems.

Figure 27 - Gagne's Hierarchy of Learning

3.3.9 Learning Styles Summary

This section discussed the rationale of using the concepts of Carl Jung's functions and Myers-Briggs Type Indicator as a basis to create the Learning Styles psychometric test in WISDeM, it overviewed a variety of models: the Dunn and Dunn Model, the Learning Style Inventory (David Kolb Model) - learning cycle, the Myers-Briggs Type Indicator® (MBTI®) - personality type designation, Fleming's VARK (Visual, Auditory, Read/Write, Kinesthetic) tool - learning preferences, Maslow's Motivational Hierarchy of Needs and Gagne's Hierarchy of Learning.

The section showed that both Fleming's VARK and the MBTI® are successful psychometric instruments that can establish Communication Preference (VARK) and Personality Types (MBTI®). The section also demonstrated that individuals need the correct motivational stimulus and that this varies as demonstrated by Maslow and further that learning takes place at different levels.

The development and design takes full cognizance of these facts and embodies, where relevant, them into the system.

3.4 Chapter Summary

This chapter showed that the way a student learns is influenced by preconceived ideas and concepts developed from birth. Each individual has a different subset of motivational factors that impinge on the ability to save instances into long-term memory, and further, their pre-conditioning influences how this is stored. In addition physiological factors such as their learning style (activist, reflector, theorist or pragmatist), preferred perceptual style (auditory, echoic or kinaesthetic) are reported to play an important part with reference to their ability to easily store, retain and recall sensory input. Reward stimulus of the relevant type aids learning; however, effective rewards can vary from individual to individual: this is often linked to their Maslow's hierarchy of needs.

This chapter also discussed Communication Preference and showed that learning is introduced by one of the five senses and further that all sensory input is filtered, interpreted and assessed against previously input, beliefs and concepts. It then to highlighted the importance of iconic, echoic and kinaesthetic memory and that individuals have a preferred sense for communication.

The chapter then introduced Neurolinguistic Programming (NLP) and NLP language patterns and showed that research confirms that inviting a subject to "see" invokes iconic, to "hear" invokes auditory and to "feel" invokes kinaesthetic recall.

Finally it discussed the basic arguments for and against Learning Styles and introduced the concept and rationale of using communication preference and learning styles (with reference to personality types) to replicate some HHI in HCI. It also highlighted that any teaching or pedagogical learning styles could run alongside the personality types learning styles – they are not mutually exclusive.

WISDeM uses concepts and ideas demonstrated in this chapter:

- Communication Preference is established by a psychometric test developed from Fleming's VARK concepts.

- Personality Types/Learning Styles are established by a psychometric test developed from Carl Jung and MBTI concepts.
- Neurolinguistic Programming language patterns and subliminal imaging textual messages are used in the intuitive interaction Questions and Answer section once the student's Communication Preference and Personality Types/Learning Styles have been established.

CHAPTER 4

WISDEM

FRAMEWORK

4 WISDeM - Framework

This chapter describes WISDeM's framework" covering:

- Overall Architecture diagram,
- Initial Student Profile creation that provides details of the way the student profile is created,
- Pseudo Code that provides top-level code data outlining the treatment of a new or existing user,
- Dialogue Network Diagrams (DND) that cover the main aspects which make up WISDeM's interactive essence,
- Expanded Model diagram description that illustrates the various components and data flow of Revision Multi-choice Q&A.

4.1 Introduction

Overall architecture lays the scene for the system. The initial student profile creation outlines how the profile is created using two psychometric tests, one to discover the student's communication preference, and the second using this to discover the student's learning style. The pseudo code lays a detailed basis for actual code creation and demonstrates the system's intuitive interactive nature and depth; and, the DNDs provide diagrammatic detail of various aspects of the system's multi-choice Q&A. The expanded model provides further diagrammatic detail to clarify how the parts make up the whole system.

4.2 Overall Architecture

WISDeM's architecture (see Fig.28) requires the user to logon to the Liverpool John Moore's Master Server. After successful logon the user access the module server by entering the address[33] on his/her PC. The system now opens and allows the used to view the front-page and the links that are open (see Pg.138 – Fig.67). To use the module folders the user needs to logon to the system by registering. The module tutor controls access. Once registration is completed the user has full use of all the modular data.

The system calls for relevant data from either the module data or via the interactive server. The interactive server has access to the learner profile data. This latter is created

[33] WISDeM's LJMU address: http://cmswjanv.livjm.ac.uk/wisdem/

by the student when he/she enters the system for the first time: this stores his/her profile in the CP-LS data repository (this remains unchanged), at the same time a further profile is created in the Learner Profile Data repository: it is this profile that is dynamically updated. On entry to the module front page (see Pg.141 - Fig.70) the student has access to all the module motivational and pedagogical data.

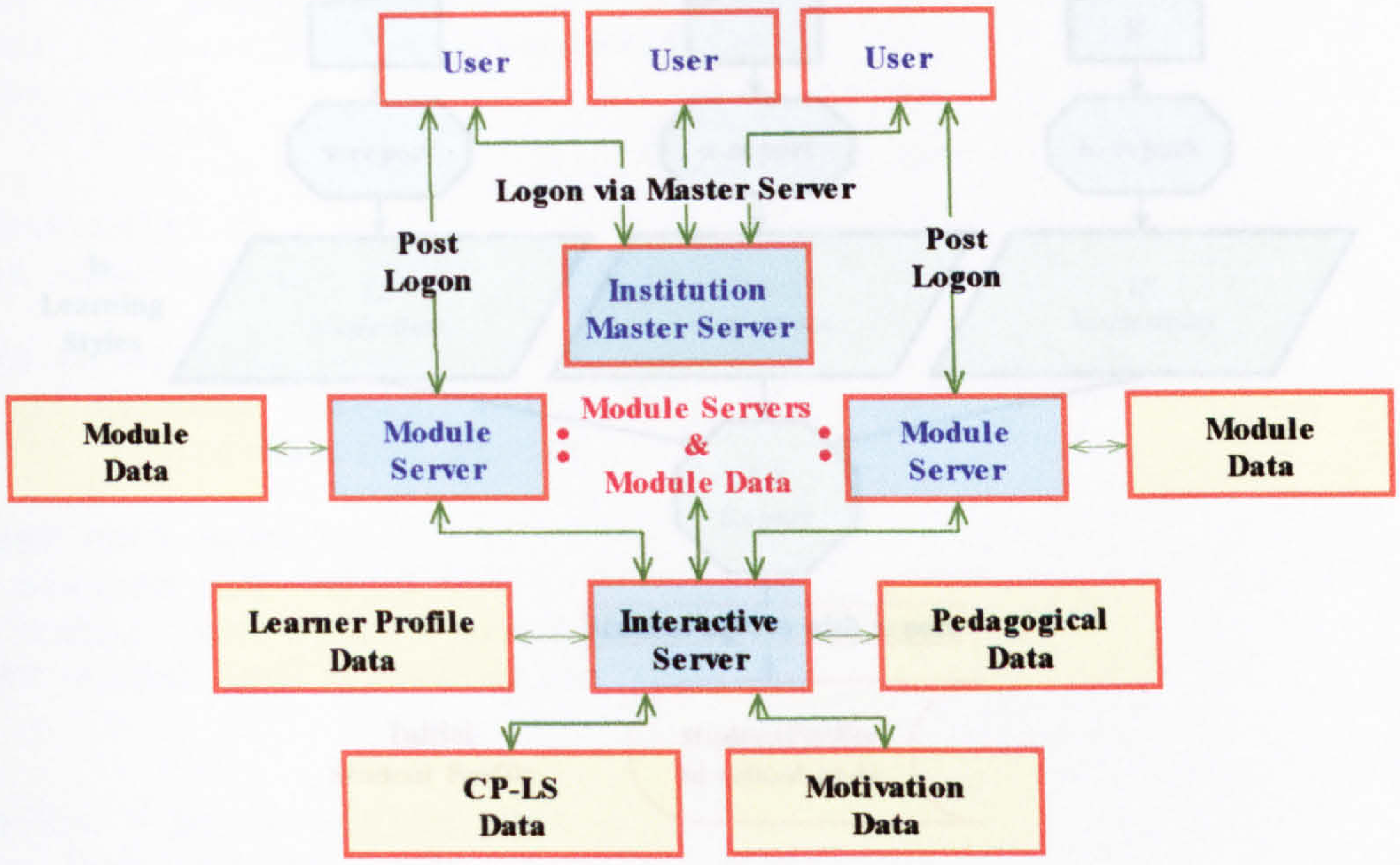

Figure 28 - WISDeM architecture

4.3 Initial Student Profile creation

It is necessary to create the initial student profile BEFORE the student accesses module learning material to enable effective human-computer interaction. Fig.29 diagrammatically represents the way the system deals with a new student. After initial login, the student completes the Communication Preference questionnaire from which the system establishes if he/she is visual, auditory or kinaesthetic. A relevant report is output and the student opens the Learning Styles questionnaire. The questions in this are couched using text that matches his/her CP.

Upon completion of this questionnaire a learning style report is produced, and, provided the student agrees, the initial Student Profile is saved in the CPLS database. The student only goes through this process once.

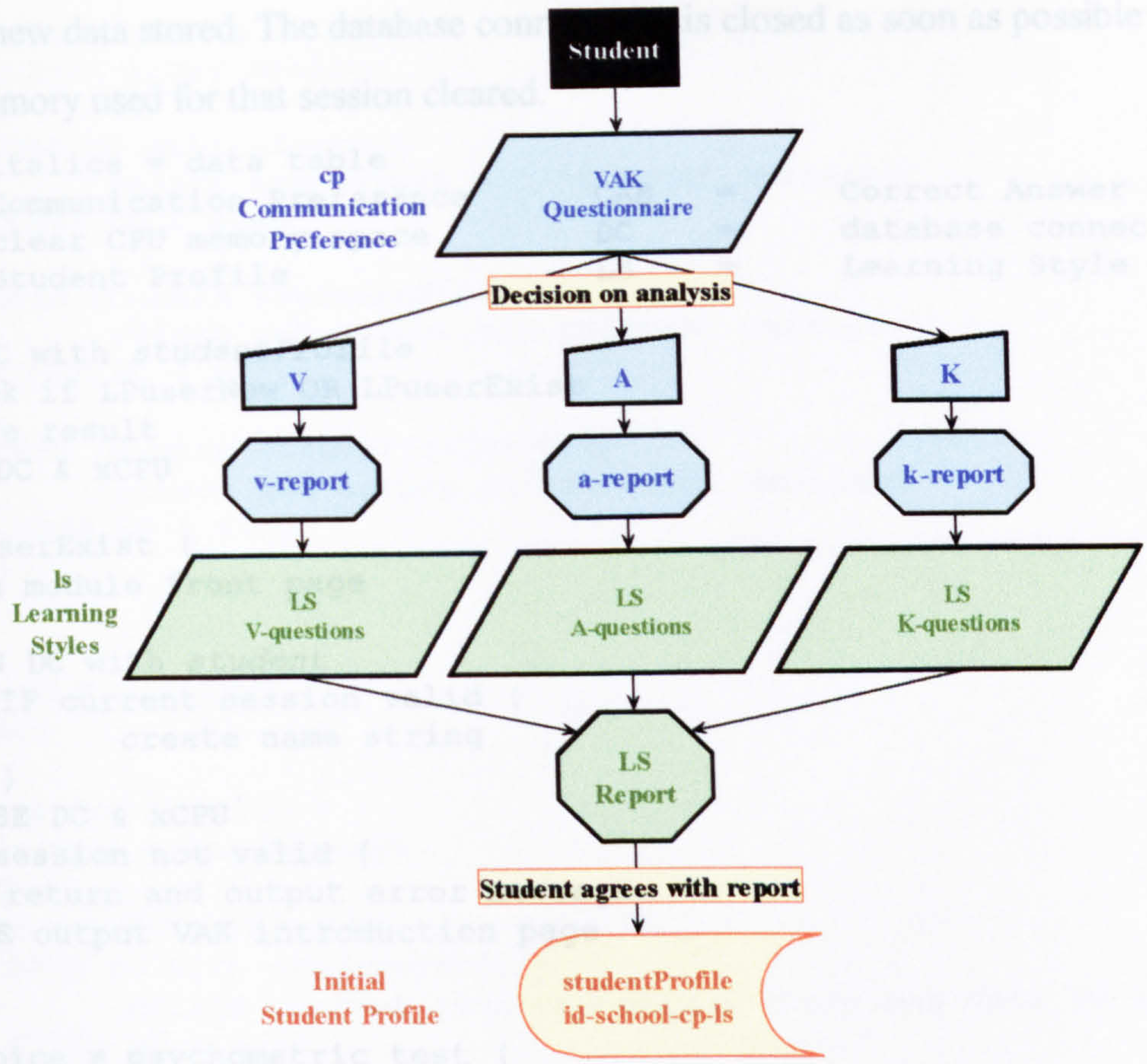

Figure 29 - Initial Student Profile flow chart

4.4 Pseudo-code

The following pseudo-code provides a guide to the way the psychometric tests are generated and used.

- Initially the system checks if the student's profile already exists.
- Assuming that it does not, the system outputs the Communication Preference questionnaire and assesses the results: the latter are stored in temporary memory.
- The system then opens the Learning Style questionnaire couched in the student's CP NLP language patterns.
- The answers are then analyzed and the relevant Learning Styles messages are output: the LS results are stored in temporary memory.
- Once the student accepts the report and decides to proceed all temporary data is stored in the relevant databases.

At relevant times the validity of the session is checked to ensure that mal information is not posted. Provided that the session is valid, to ensure integrity of the data being stored, whenever any data is being stored in the database the existing entries are deleted and the new data stored. The database connectivity is closed as soon as possible and the CPU memory used for that session cleared.

```
Note: italics = data table
CP =   Communication Preference        CAB   =   Correct Answer Button
xCPU=  clear CPU memory space          DC    =   database connectivity
LP =   Student Profile                 LS    =   Learning Style

OPEN DC with studentProfile
  Check if LPuserNew OR LPuserExist
  Store result
CLOSE DC & xCPU

IF LPuserExist (
  open module front page
ELSE
  OPEN DC with student
     IF current session valid (
          create name string
     )
  CLOSE DC & xCPU
  IF session not valid (
     return and output error message
  ELSE output VAK introduction page
  )
)
IF choice ≠ psychometric test (
  Open Module front-page
ELSE OPEN DC with VAKquestions
     Get & output CPquestions
  CLOSE DC &xCPU
  Store answers
)
IF choice ≠ submit (
  reset page
ELSE
  IF selection < 7 (
     return
  ELSE
     assess answers
     store relevant CP
     output relevant messages
  )
)
IF choice ≠ next(
  return
ELSE
  open LSintroduction
)
On select next page
OPEN DC with LSquestions where questions match CP
  Get & output LSquestions
CLOSE DC & xCPU
Store answers

IF choice ≠ submit (
  reset page
ELSE
  process stored data
```

```
  IF stored answers ≠ valid (
      output error message
  ELSE
      OPEN DC with LSreport
            select and output all relevant messages
      CLOSE DC & xCPU

      OPEN DC with LearningStyles
            select and output all relevant messages
      CLOSE DC & xCPU

      OPEN DC with JungianPreferences
            select and output all relevant messages
      CLOSE DC & xCPU
  )
)

IF choice ≠ continue (
  return
ELSE
  IF session ≠ valid (
      output error message
  ELSE
      process stored data
      OPEN DC with studentProfile
            delete current student entry & store new data in database
      CLOSE DC & xCPU

      OPEN DC with studentActiveModuleProfile
            delete current student entry & store new data in database
      CLOSE DC & xCPU

      OPEN DC with studentActiveTopicProfile
            delete current student entry & store new data in database
      CLOSE DC & xCPU

      open module front page
  )
)
```

4.5 Dialogue Network Diagrams (DND)

The following DNDs provide further detail of the flow for: i) logon, ii) creation of the Students CP and LS Profile, iii) Revision Multi-choice Q&A in its various section, and iv) Student Profile maintenance.

Fig.30 (DND - Logon Dialogue Network Diagram) shows the flow required for a student to logon. On opening the system there are limited facilities. Provided the student is authorized the system checks if he/she has completed the psychometrics test and opens the relevant page.

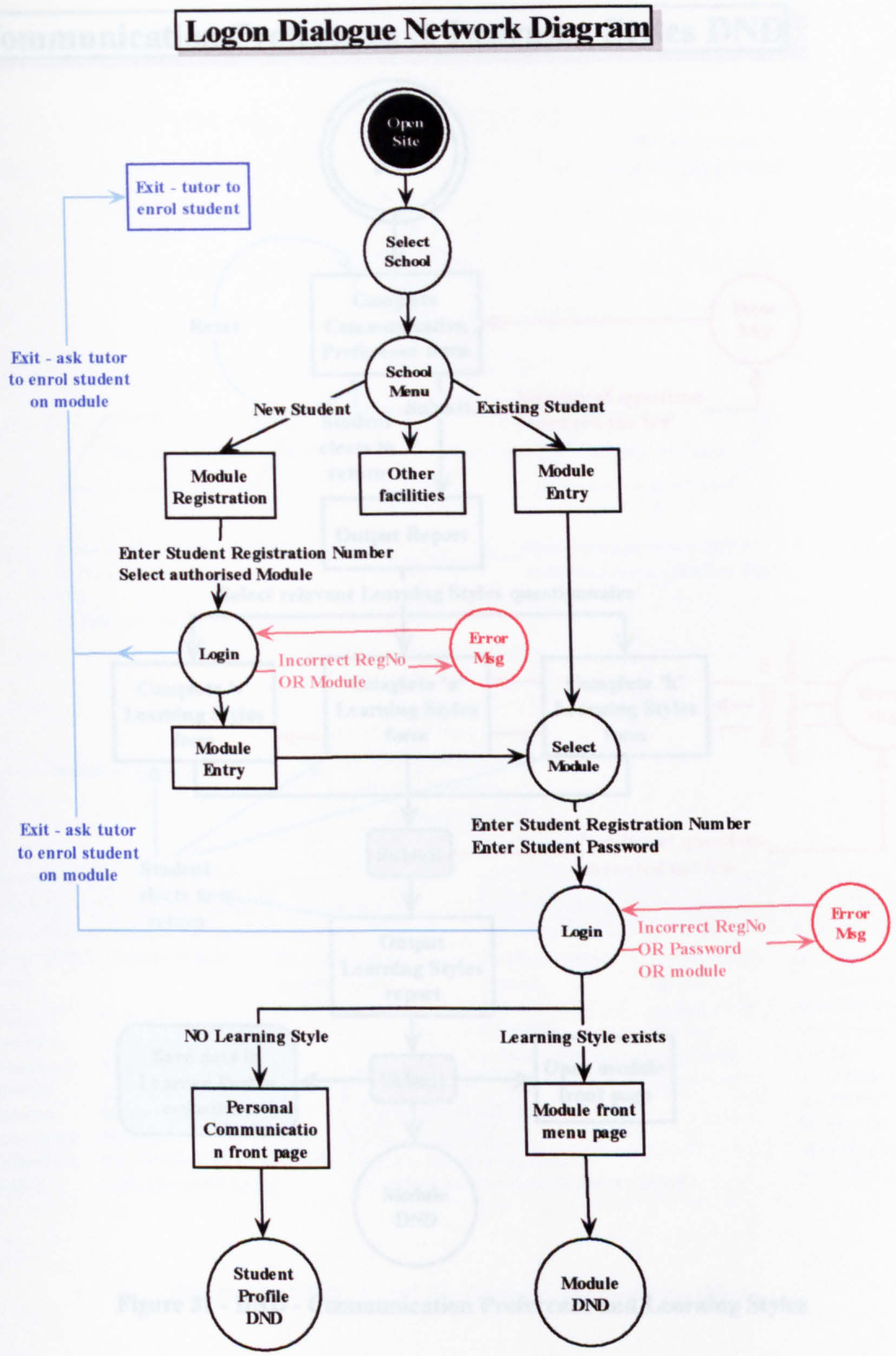

Figure 30 - DND - Logon Dialogue Network Diagram

Communication Preference & Learning Styles DND

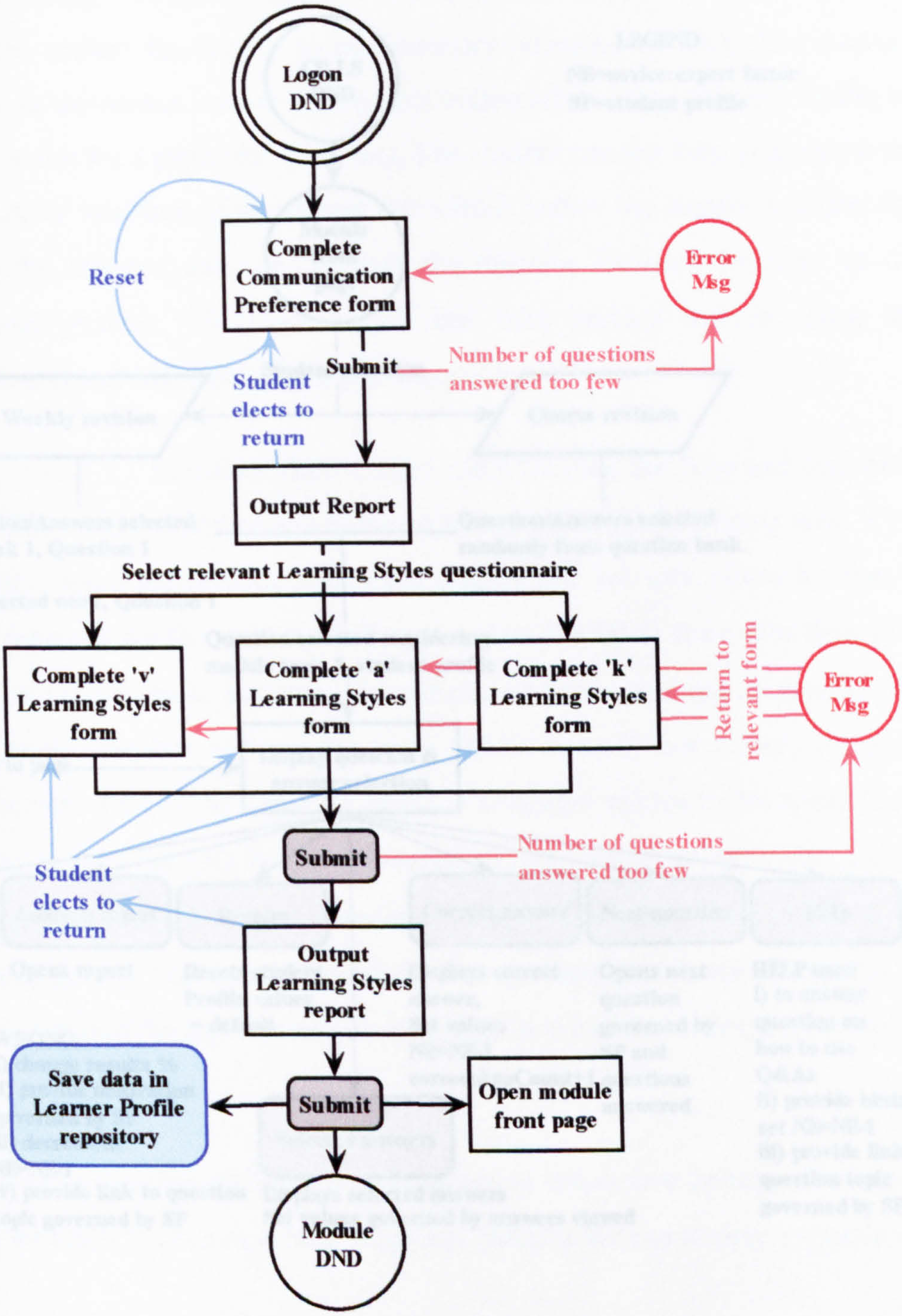

Figure 31 - DND - Communication Preference and Learning Styles

Fig.31 covers the same ground as the pseudo code above but in diagrammatic form.

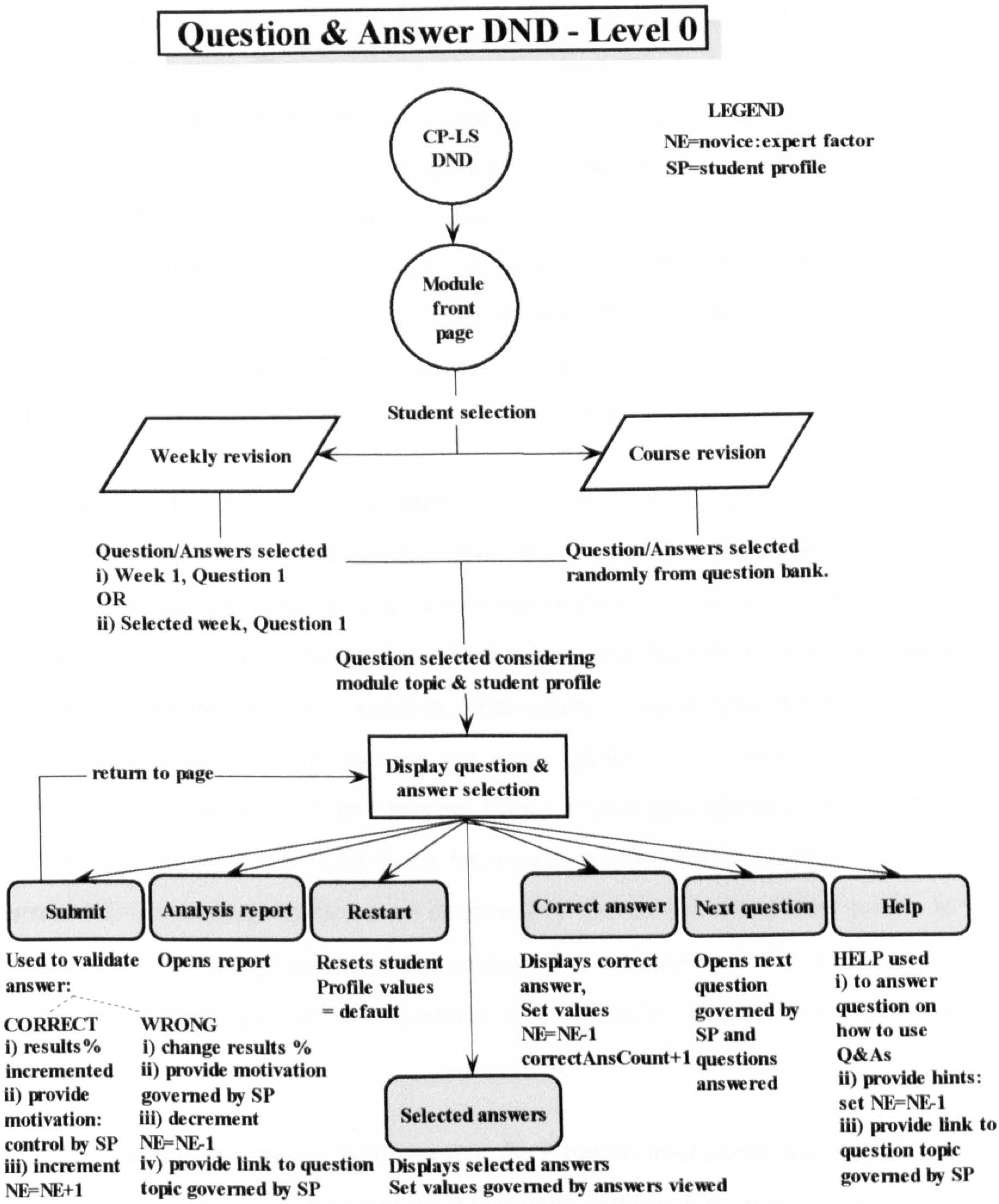

Figure 32 - DND - Level 0 - Revision Multi-choice Q&A

Fig.32 is the top level DND for the intuitive interactive part of the system. The student can select to either do weekly revision or course revision. The former is the main interactive learning section; the latter allows the student to self-test from random questions selected by the system from all the module questions set. This facility offers little feedback and allows the student to self-test without the interactivity required to learn being involved.

Weekly revision allows the student to select any week/topic for learning or, chronologically testing. The system displays a question and three multi-choice answers. It also offers the student the facility to use 'memory rehearsal by using the selected answers button, or the correct answer button (this button affects the statistical results by recording its first use for a particular question). The student can use help or go on to the next question. After selection of an answer the submit button the system analyses the answer, stores the required data, and outputs the relevant feedback (relevant to the student's updated profile). The student can then take various options: open the analysis/statistical report and restart the topic or module.

Fig.33 (DND - Level 1 - Revision Multi-choice Q&A) shows the flow and actions to greater depth. The system differentiates between a new user and an existing user. If the latter, the system opens the revision where the student last left and allows him/her to continue. The facilities are the same for both types, thus this DND shows the flow for a new user. A user can be visual, auditory, kinaesthetic or have opted not to complete the psychometric tests. This last will see the same Q&As but will not receive the same feedback or support. Part of the Learning Styles assessment relates to the speed that a student likes to move - the MQ factor (measured pacing, quick pacing) - this and the current NE (novice|expert) factor are dynamically changed in the student profile as the student proceeds through the topic and module. The novice|expert factor changes as the student process through the topic questions: it returns to the default when a new topic is started.

The DND shows the various facilities that the intuitive interactive system offers and it shows that at all times the relevant NLP language patterns for the student's specific CP are used.

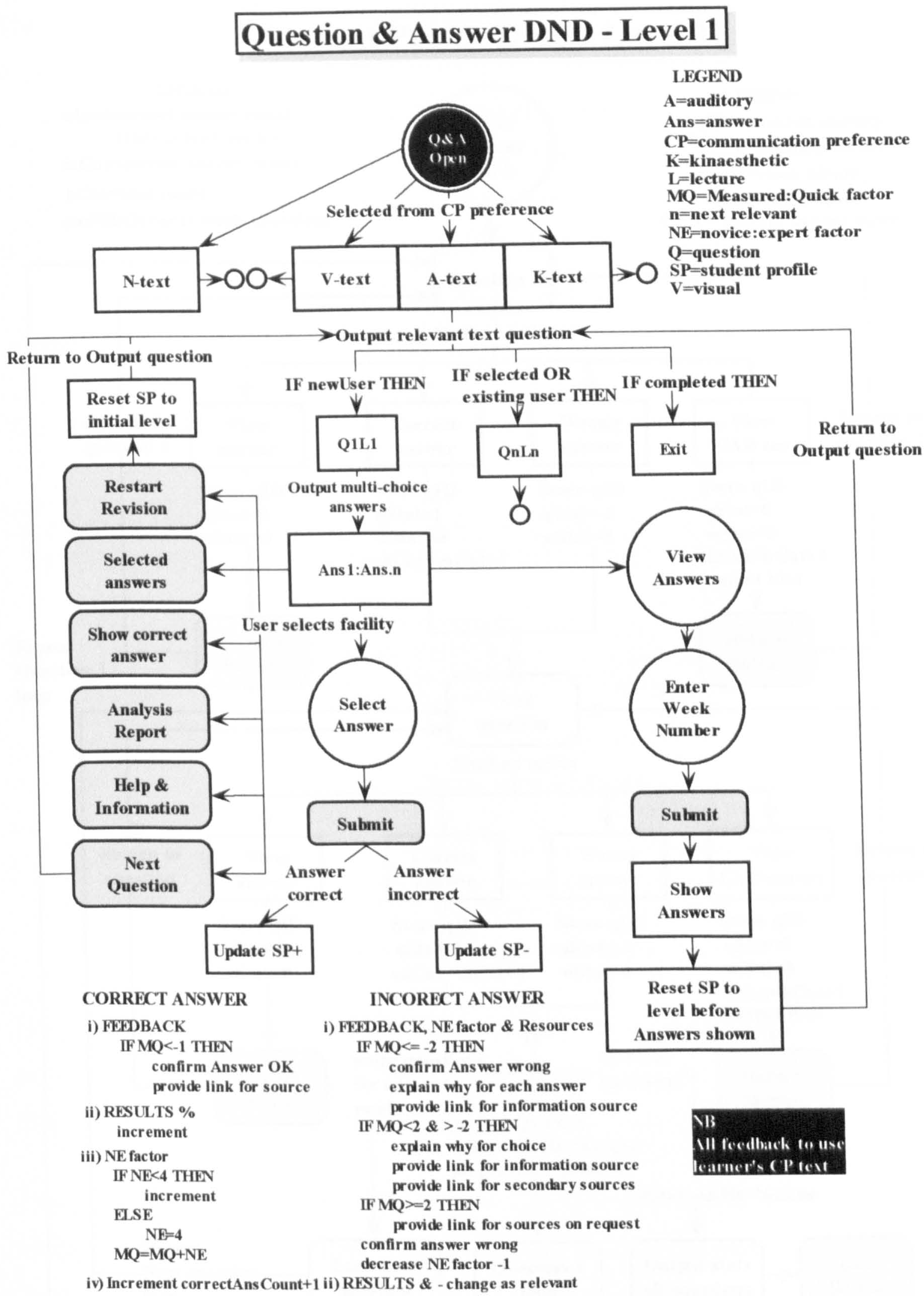

Figure 33 - DND - Level 1 - Revision Multi-choice Q&A

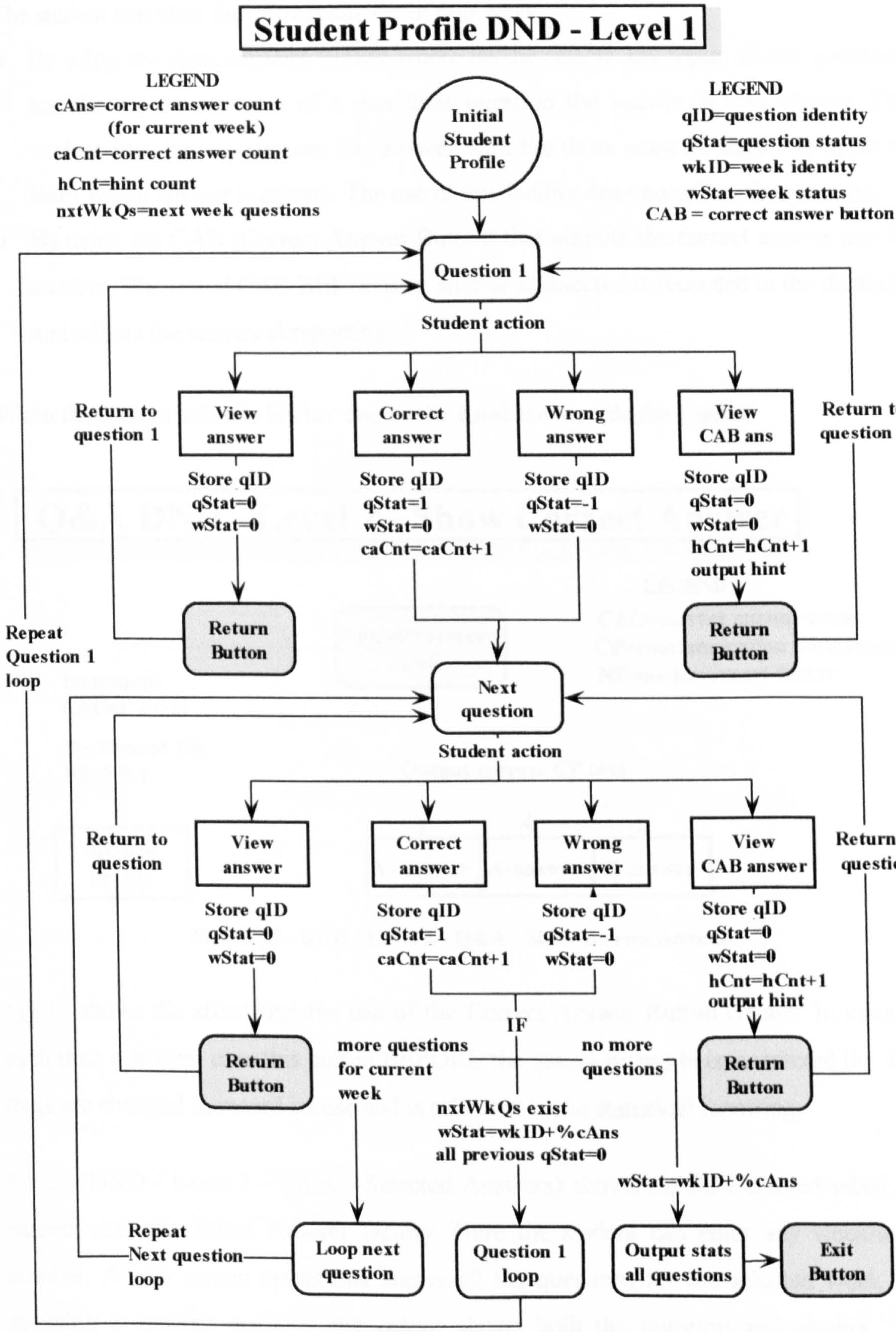

Figure 34 - DND - Level 1 - Student Profile

Fig.34 shows the flow and the changing flag status as a student uses the multi-choice Q&A system.

The student can view the correct answer in two ways:

- By using the view answers facility where he/she selects any topic, all the questions are shown, on selection of a particular question the answer is also shown. The student now has to compare this answer with the three answers shown in order to learn which answer is correct. The use of this facility does not affect the database.
- By using the CAB (Correct Answer Button) that outputs the correct answer and its number. The use of CAB BEFORE an answer is selected is recorded in the database and affects the statistical reporting.

When the student submits his/her choice the database records the results.

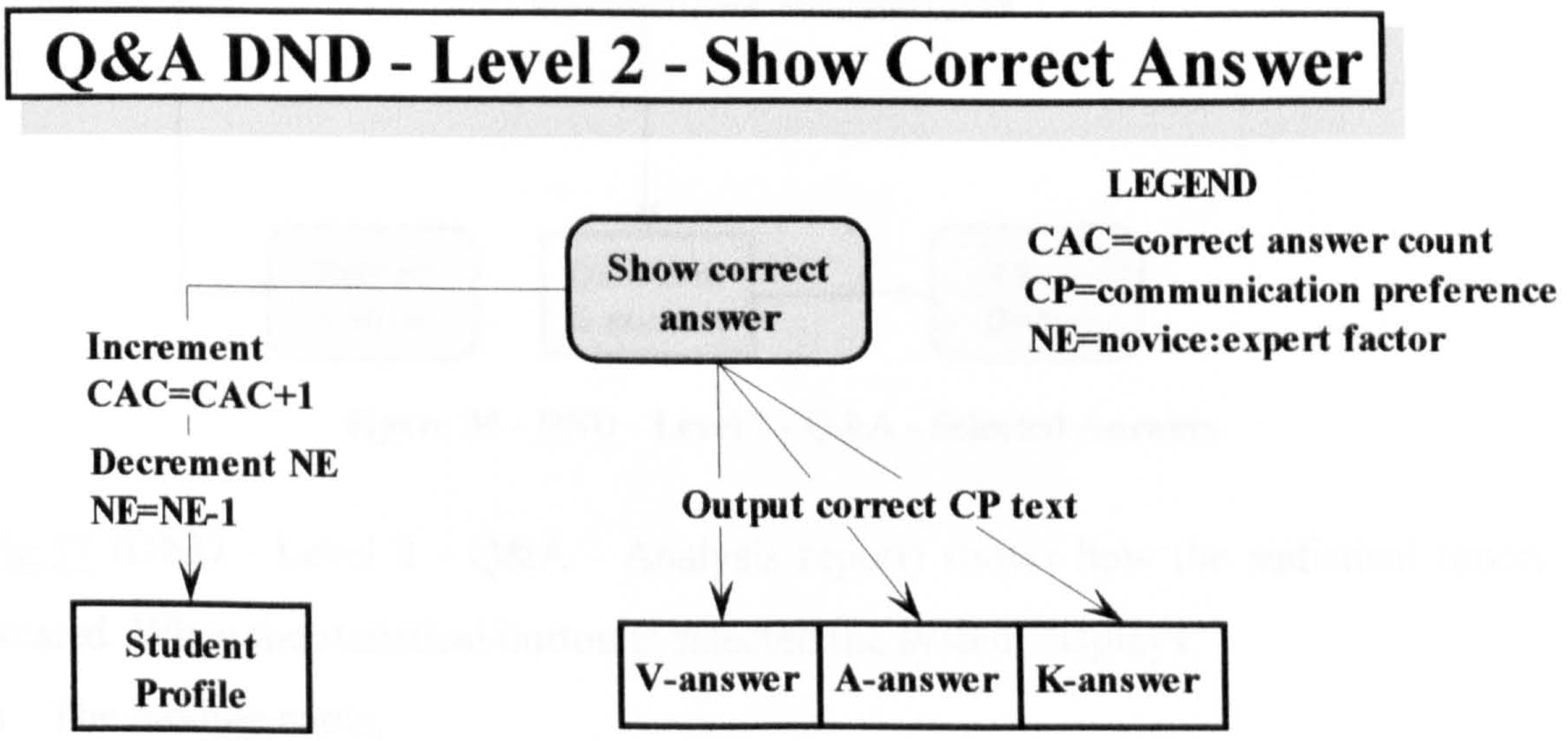

Figure 35 - DND - Level 2 - Q&A - Show correct Answer

Fig.35 shows the affect that the use of the Correct Answer Button creates. In essence each time a student uses this button BEFORE the questions has been answered the data flags are changed to record its use and is reflected in the statistical reporting.

Fig.36 (DND - Level 2 - Q&A - Selected Answers) shows the flow created when the student uses the Select Answer facility. Here the student can enter any week/topic number. A new screen opens that shows all the questions for the selected week. On selecting a specific question the output shows both the question and answer. The student can either close the window or return to view another question.

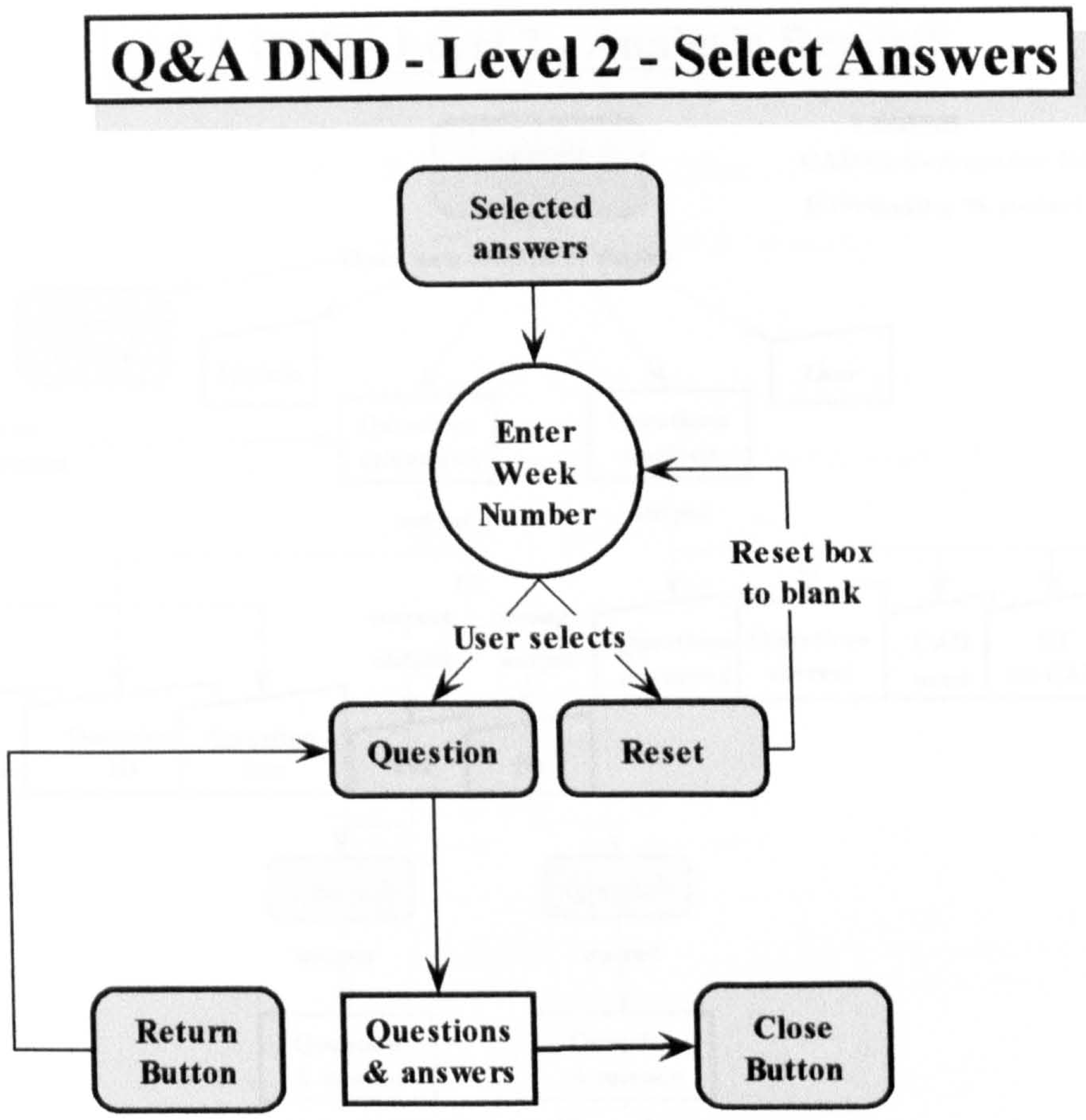

Figure 36 - DND - Level 2 - Q&A - Selected Answers

Fig.37 (DND - Level 2 - Q&A - Analysis report) shows how the statistical report is created. When the statistical button is selected the system displays:

- The module name,
- The user name,
- The week number,
- The questionID,
- The question text,
- Whether or not the questions was answered correctly,
- The number of topic and module questions answered,
- The number of topic and module questions answered correctly,
- The topic and module marks running total percent,
- The topic and module marks percent taking into consideration the use of the CAB button.

The student can opt to see any of the answers; upon selection the system displays the relevant question and answer. Topic results are displayed in one section and module results are displayed in another.

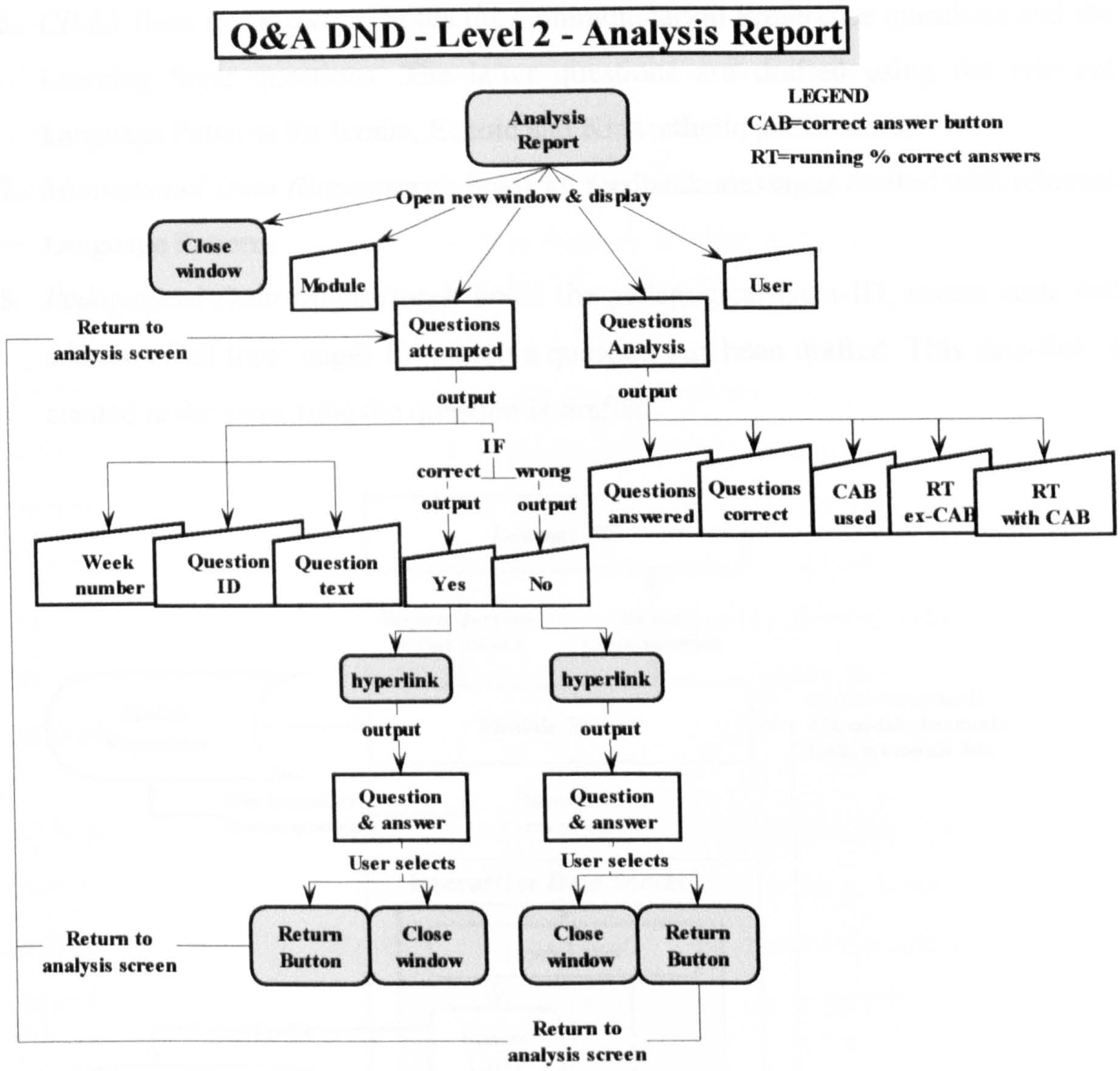

Figure 37 - DND - Level 2 - Q&A - Analysis report

4.6 Expanded Model

This model (see Fig.38) shows the Revision Multi-choice Question and Answer flow that is designed into WISDeM. This section is used to enhance the student's memory rehearsal and recall of knowledge by using the student's own communication preference and learning styles by incorporating subliminal text messaging using NLP language patterns.

1. *Learner PC*: links the user to his/her requested Module.
2. *Module Server*: contains all module material
3. *Module Data (Repository)*: contains all non-Interactive data used for the various module topics
4. *Interactive Server*: effects all the intuitive interactive data links
5. *Student Profile Data (Repository)*: contains the updated profile of all system users

6. *CP-LS Data (Repository)*: holds the Communication Preference questions and the Learning Style questions. The latter questions are drafted using the relevant Language Patterns for Iconic, Echoic and Kinaesthetic preferences.
7. *Motivational Data (Repository)*: holds all feedback messages drafted with relevant Language Patterns.
8. *Pedagogical Data (Repository)*: holds the pedagogical-Data-ID, access code and address of all topic pages for which a question has been drafted. This data-link is created at the same time the question is drafted.

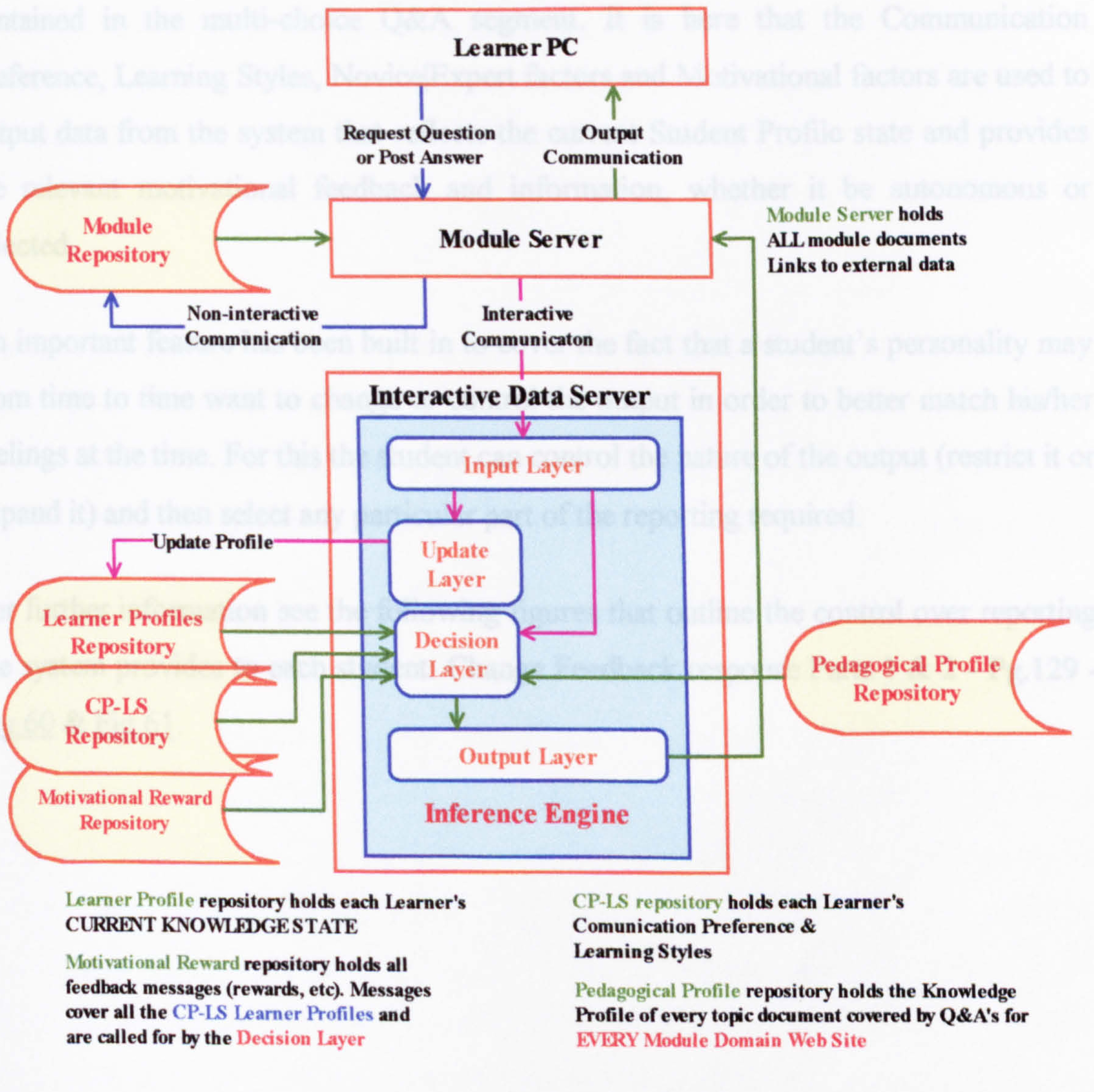

Figure 38 - WISDeM architecture - expanded diagram

4.7 Chapter Summary

This chapter described WISDeM's framework by initially discussing its Overall Architecture and how the system fits into the university's facilities. Then it described how the initial Student Profile is created and held, unchanged, in the Student's Profile repository. It also gave a detailed Pseudo Code that provides top-level code data outlining how a new or existing user is dealt with by the system. Detailed Dialogue Network Diagrams, which covered the WISDeM's main intuitive interactive essence, backed this up. The Expanded Model diagram further describes flow between the various components highlighting the data flow used when a student uses the Revision Multi-choice Q&A.

Briefly this chapter outlined WISDeM design, as executed, and showed that the main aspect of its development is in the intuitive interactive section of the system that is contained in the multi-choice Q&A segment. It is here that the Communication Preference, Learning Styles, Novice|Expert factors and Motivational factors are used to output data from the system that reflects the current Student Profile state and provides the relevant motivational feedback and information, whether it be autonomous or selected.

An important feature has been built in to cover the fact that a student's personality may from time to time want to change or control the output in order to better match his/her feelings at the time. For this the student can control the nature of the output (restrict it or expand it) and then select any particular part of the reporting required.

For further information see the following figures that outline the control over reporting the system provides to each student: Change Feedback response Parts 1 & 2 - Pg.129 - Fig.60 & Fig.61.

CHAPTER 5

WISDEM

INTUITIVE INTERACTION

5 WISDeM – Intuitive Interaction

This chapter discusses:

- Student Learning Styles and Teaching Styles,
- Student Profile
  - The initial Student Profile Model,
  - Communication Preference and Learning Styles tests output and validation,
- The initial student profile development
  - Communication Preference algorithm and pseudo code,
  - Learning Styles algorithm and pseudo code,
- Development of the Communication Preference and Learning Styles questions,
- Question Knowledge and Motivation input.
- WISDeM's pedagogical standards.

5.1 Introduction

The rationale of mapping teaching styles and learning styles is discussed. Each tutor has his/her own communication preference and personality, which means that he/she has their own comfort zone for imparting knowledge; this, of course, equates to their own learning style. These are discussed and related both to VARK communication preference and to the MBTI® personality types.

WISDeM's Student Profile assessment using the Communication Preference (CP) and Learning Styles (LS) questionnaires is discussed and the way the questionnaires were developed and validated is outlined. Their limitations and requirement for future large-scale validation is specified. The initial student profile development is outlined by the Communication Preference algorithm and pseudo code, and Learning Styles algorithm and pseudo code: both provide insight to the coding development. The way the Communication Preference and Learning Styles questions were developed is outlined and the requirement for motivational factors to be included is discussed and then the various sources for the required pedagogical knowledge for teaching and motivation are outlined. Finally WISDeM's pedagogical standards are outlined with a specific example.

5.2 Student Learning Styles and Teaching Styles.

Learning styles make intuitive sense, people are different; and, therefore it can be argued that these differences can be accommodated in learning by using their own preferred style. For example, observation of people in everyday life shows that some prefer to read rather than listen, some prefer to work alone rather than in groups.

(Keefe, 1987) in his "Learning Style Theory and Practice" defines Learning Style as *"...the set of cognitive, emotional, characteristic and physiological factors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment..."*.

(Robotham, 1999) states that *"... Learning style is a gestalt combining internal and external operations derived from the individual's neurobiology, personality and development, and reflected in learner behaviour ..."*. Learning Styles equate to Teaching Styles: a leaner becomes a tutor and normally reflects their own communication preference and personality types. Outwardly changes can be manifested in both CP and LS to interact with a subject more effectively: this takes extra effort and concentration and, by default, tutors will gravitate to their own preference and types.

(Montgomery & Groat, 1998) points out that "*matching teaching styles to learning styles is not a panacea that solves all classroom conflicts*" that other factors such as the student's motivation, pre-conceptions, multicultural issues, etc. also impinge on the student's quality of learning; but that, nonetheless, understanding and reacting to learning styles in teaching enhances the quality of learning and rewards teaching. Learning is enhanced where suitable rewards are offered provided that they are introduced at the relevant times as governed by the learner's psyche. An e-learning module automatically provides Maslow's Cognitive Level[34] motivational factor, whereas the Esteem Level[35] needs to be coded in the system.

Mapping Learning Styles to Teaching Styles as outlined by (Fuller et al., 2000; Lewis, 1998) provides a suggestion of requirements linked to personality types (see Fig.39).

Type	Teaching Style
Extravert	Facilitate trial and error opportunities

[34] **Cognitive Level**: knowledge, understanding, curiosity

[35] **Esteem Level**: self-esteem, self-worth, respect from others

	Allow student to discover for her/his-self
	Provide learning activities that are action-orientated
	Provide changes in the environment
	Break long tasks requiring depth of concentration into units
Introvert	Facilitate in-depth introspective opportunities
	Allow time to contemplate before taking action
	Do not assume that inter-communication is complete
Sensor	Provide hands-on projects - not too complex
	Provide drill-and-practice problems
	Provide sample solutions that only have one best answer
Intutitor	Use open-ended essay or design problems
	Provide innovation and complexity in work
	Do not provide routine tasks (drill-and-practice problems)
Thinker	Use experiments/problems requiring logic to solve
	Provide cause-and-effect reasoning problems
	Use constructive comments/critique
Feeler	Use personal contact assignments
	Do not provide cause-and-effect reasoning problems
	Flag constructive comments/critique as not personal
Judger	Provide detailed course syllabus with 'What-by-When'
	Allow time to contemplate before taking action
	Provide results feedback
Perceiver	Provide flexibility
	Provide help to set their schedule
	Provide good process information
	Allow time to contemplate before taking action

Figure 39 - MBTI Teaching Criteria

(Fuller et al., 2000) in their research posed the question "*Does personality type and preferred teaching style influence the comfort level for providing online instruction?*", their answer was "Yes". They outlined the Teaching Styles preferences for the Myers-Briggs Type Indicators® – **E**xtroversion | **I**ntroversion, **S**ensing | i**N**tuition, **T**hinking | **F**eeling, **J**udgement | **P**erception (see Fig.40), and provided some suggestions for faculty development linking to the four couplets/sixteen[36] MBTI® types.

Extroversion (E)	Introversion (I)

[36] **Sixteen MBTI® types**: ESTJ – ESTP – ESFJ – ESFP – ENTJ – ENTP – ENFJ – ENTJ - ISTJ – ISTP – ISFJ – ISFP – INTJ – INTP – INFJ – INTJ

Teaching approach uses discussion and cooperative learning.	Teaching approach uses lecture and verbal tasks.
Prefers variety and activity.	Likes quiet for concentration.
Likes having people around.	Likes working alone.
Often acts quickly without thinking.	Likes to think a lot before taking action.
Prefers face-to-face group discussion to written communication.	Likes to communicate one-on-one.
Develops ideas through discussion with others.	Develops ideas through reflection.
Often impatient with slow moving tasks and welcomes interruptions.	Tends to work for long periods of time and prefers to not be interrupted.
Sensing (S)	**iNtuition (N)**
Uses traditional curriculum and step-by-step instructional methods for teaching.	Focuses on conceptual understanding and the use of self-instructional methods for teaching.
Likes using past experiences and standard ways to solve problems.	Likes solving new and complex problems.
Enjoys applying what is already known by giving examples and details.	Enjoys learning new skills more than using them.
May ignore and not trust their inspirations.	Willing to follow their insights and relies on imagination.
Likes suggestions that are straightforward and feasible.	Likes novel and unusual suggestions.
Are inclined to follow an agenda.	Prefers change and proceeds with bursts of energy to follow global schemes.
Likes to do practical things and prefers realistic applications.	Likes to do innovative things.
Seldom makes errors of facts.	May make errors of facts.
Thinking (T)	**Feeling (F)**
Uses teacher-directed instructional approaches and peer tutoring.	Uses simulations and case studies together with small group work for teaching.
Uses logical analysis to reach conclusions.	Uses values to reach conclusions.
Can work without harmony.	Works best in harmony.
Is firm-minded and has little trouble giving criticism.	Tends to be sympathetic and has difficulty providing criticism.
Feels rewarded when task is done.	Feels rewarded when people's needs are met.
Seeks involvement with tasks.	Seeks involvement with people.
Presents goals and objectives first.	Presents points of agreement first.
Tends to be brief and concise.	Is sociable and friendly.
Judgment (J)	**Perception (P)**
Uses formalized instruction and predictable routines in teaching.	Uses independent study projects as preferred teaching approach.
Works best when they can plan their work & follow their plan.	Enjoys flexibility.
Likes to get things settled and finished.	Likes to leave things open for last minute changes.
Tends to be satisfied once a decision is reached.	Tends to postpone unpleasant tasks.
Reaches closure quickly.	Tends to postpone decisions while searching for different options.
Seeks structure and schedules deadlines.	Adapts well to changes and feels restricted without opportunity for change.
Focuses on the task.	Focuses on the process.
Expects others to follow through and is depends on it.	Expects others to change and adapt.

Figure 40 - MBTI Teaching Style preferences (Fuller et al., 2000)

(Brightman, 2000) discusses the four MBTI® sections and provides guidance on matching Learning and Teaching styles (see Fig.41) and reports that the MBTI (Form G) is the most reliable method for assessing student learning style.

Extroversion (E)	**Introversion (I)**
Learn by explaining to others - learn by working in groups - learn by group discussion.	Want to develop frameworks that integrate or connect the subject matter - learn by chunking the material - building compare/ contrast tables, flowcharts, or concept maps.
Sensing (S)	**iNtuition (N)**
Prefer organized, linear, and structured lectures - learn by prioritizing what they must know, and by trying to solve any problem before being provided with the way to solve it.	Learn by discovering for themselves - trying to discover the theory
Thinking (T)	**Feeling (F)**
Learn by having clear course and topic objectives - objectives need to be precise and action-oriented	Learn by being part of a harmonious group - by doing small group exercises
Judgment (J)	**Perception (P)**
Focus on completing the task, only want to know the essentials, and take action quickly (perhaps too quickly).	Are curious, adaptable, and spontaneous. Start many tasks, want to know everything about each task, and often find it difficult to complete a task. Deadlines are meant to be stretched.

Figure 41 - Learning and Teaching – suggestions for learning requirements

There is a body of research that supports MBTI concepts and, in Chapter 2 *'Communication Preference and Learning Styles'*; the thesis establishes that MBTI® assess learning styles where these are referred to personality types with a good degree of validity and reliability (see 5.3.1.4 Learning Styles test validation).

5.3 The Student Profile

This section describes the initial Student Profile model (output and validation) and development (algorithm pseudo codes).

5.3.1 The initial Student Profile Model

Both of the psychometric questionnaires were built using the concepts and principles researched covering VARK and MBTI®. Once the first psychometric questionnaires had been completed, a detailed evaluation of the questionnaire and the results was instigated with a few LJMU subjects in order to establish whether or not the profiling system appeared to be true reflection of actuality. Initial research was very encouraging with each subject basically agreeing with the report and providing specific feedback. This feedback was invaluable: it allowed the psychometric test flow and presentation to be changed to accommodate suggestions.

5.3.1.1 Communication Preference test output

WISDeMs' CP is limited to iconic, auditory and kinaesthetic input. The test establishes which of these the subject prefers to use. Once the CP is established the interface output uses the user's relevant NLP language pattern (Visual, Auditory or Kinaesthetic).

5.3.1.2 Communication Preference test validation

Fleming's VARK deals with only one dimension of the complex blend of preferences that make up a learning style; however, it is claimed to provide users with a profile of their preferences about the ways that they want to take-in and give-out information whilst learning. An underlying problem with Fleming's VARK is that there is no apparent evidence of reliability or validity: the instrument addresses sensory perceptions, makes intuitive sense and therefore could be viewed as having some face validity[37] (N. Fleming, 2002; N. D. Fleming & Mills, 1998).

VARK's psychometric test was researched in depth both on the Internet and with specific papers (e.g. Google lists 275 sources for the search on "*VARK questionnaire*" many of which discuss VARK and refer the user to Flemming's web site - http://www.vark-learn.com/english/page.asp?p=questionnaire, in addition see sources listed in Pg.276 '*Communication Preference and Learning/Learning Styles research*'). From this research the Communication Preference psychometric questions were developed to cover the three main sensory inputs (seven for each – V, A and K).

WISDeM's Communication Preference psychometric test validity is connected to observable HHI and NLP where the conscious observation of eye movement can establish a subject's communication preference as Iconic, Auditory or Kinaesthetic and result in the use of relevant NLP language patterns. The questionnaire was tested with one Doctor and five PhD research students. This involved a discussion with the subject during which time past, current and future experiences were covered. The discussion lasted until an accurate prognosis could be made: usually between twenty and thirty minutes. During this time the subject's eye-movements and body language were observed and his/her communication preference noted as either V or A or K. The student was then asked to take the CP psychometric test and to comment on its

[37] **VARK face validity** – In June-September 2002 the VARK database recorded 31243 respondents (N. Fleming, 2002)

wording, style, HCI content and their own subjective feelings about the results. The following results were recorded:

- Using a scale of 1= do not agree : 10=fully agree
  - *Do you consider that this CP matches your own ideas?*
    Average = 9.00 (variance 10:8)
  - *Was this section easy to complete?*
    Average = 10.00
- Of the six subjects 3 were female (1 Dr & 2 PhD) and 3 male (PhD)
- Average age = 25
- Preference: Visual = 4, Auditory = 2, Kinaesthetic = 0

The small number of participants provided significant results supporting the CP psychological test; however, is must be noted that the methodology requires that the evaluator/interviewer has the depth of training to enable accurate assessment of observed communication preference: this requires the time to interact with the subject using neutral verbal language and body language controlled in such a way so as to not in anyway affect the subject[38]. Though the results provide a significant indication that the test is valid, they are not definitive proof. Even using self-testing of a large number of subjects would still leave an underlying question with regard to its validity. To be more definitive requires a large number of skilled interviews compared with a large number of self-testing results. The indication of the CP test was sufficiently significant to be able to move forward and use it in WISDeM.

5.3.1.3 Learning Styles test output

WISDeMs' LS is limited to establishing a subject's personality types to enable the mapping of the results so that the interface outputs the relevant amount of information, content and feedback for the specific user's types. This is established by mapping each subject to the Measured – Quick and Friendly – Reserved quadri-section:

[38] **Affect the subject** – language has to be strictly controlled to contain no visual, auditory or kinaesthetic words, body language has to be controlled so as to not invoke sympathetic reaction from the subject (e.g. Nodding the head to suggest that the answers are as expected, leaning forward to show interest, facial muscle changes to convey agreement or disagreement). The main concern is that the subject must not be given any indication as to the outcome of the interview session that would lead to the subject selecting in the questionnaire responses that match the perceived results of the interview.

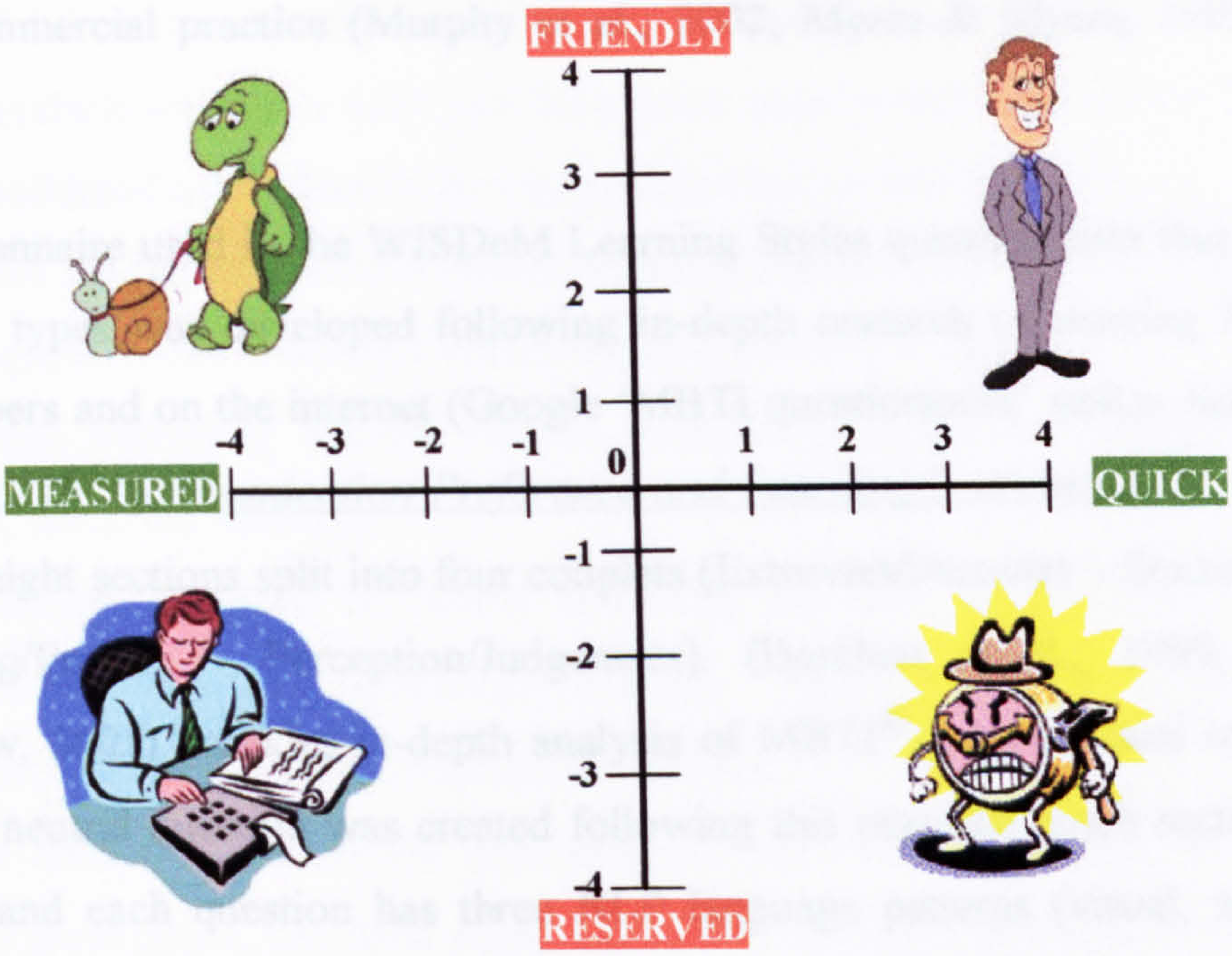

Figure 42 - Personality Types (Friendly-Reserved-Measured-Quick)

5.3.1.4 Learning Styles test validation

Research shows that the MBTI® personality assessment instrument is more widely used by educators in the US than any other. MBTI® is a self-report personality inventory designed to give people information about their Jungian psychological type preferences[39] developed by Isabel Briggs Myers and Katherine Cook Briggs from the early 1940s. (Murphy et al., 2002) reports that more than three million MBTI®s are conduct U.S.A each year and that the system is widely used around the world in many languages: excellent face validity. The major concern with MBTI is that, while the underlying theory presents each scale as two dichotomous points rather than a continuum, validity and reliability studies assume each scale is continuous, possibly making these studies inappropriate: some researchers consider that the instrument should be validated using studies designed for dichotomous variables (Briggs/Myers & McCaulley, 1985; Johnson, 1992; Kakabadse et al., 2004). Notwithstanding this, using the test to establish personality types is considered valid (Coffield, Moseley et al., 2004)

[39] **Jungian psychological type preferences**: Carl G Jung was a Swiss psychiatrist (1875-1961) who identified certain psychological types (Extroversion/Introversion - Judgement/Perception). Between the ages of 12 and 20 we develop and use the auxiliary function as a powerful support to the dominant function, from 20 to 35 we begin to use our tertiary function more frequently and with better success, from 35 to 50 we pay attention to our inferior function and from 50 onwards we tend to use all four functions in a rounded manner. Research indicates that people, without a strong auxiliary function to complement their dominant function, have problems in dealing with communications and that the introvert personality type tend to hide their dominant function and show their auxiliary function to the world: the extrovert type show their dominant function (William A. Janvier & Ghaoui, 2003b; Wilson et al., 2002).

and by commercial practice (Murphy et al., 2002; Myers & Myers, 1995; Tierney, 2001).

The questionnaire used in the WISDeM Learning Styles questionnaire that establishes personality types was developed following in-depth research of existing MBTI tools both in papers and on the internet (Google 'MBTI questionnaire' online lists 349 links and see Pg.276 '*Communication Preference and Learning/Learning Styles research*'). There are eight sections split into four couplets (Extrovert/Introvert – Sensing/iNtuition – Thinking/Feeling – Perception/Judgement). (Borchert et al., 1999; Quenk & Kummerow, 2001) provides in-depth analysis of MBTI® questions and reports. Each individual neutral question was created following this research. Each section has five questions and each question has three NLP language patterns (visual, auditory and kinaesthetic). The user's established CP controls the interface output.

Whilst Chapter 2 establishes that the concepts promulgated by Jung and Myers-Briggs are valid, validity of the WISDeM Learning Styles questionnaire needs to be established. This was initially covered in two ways:

- One comparative analysis with an MBTI® test after running a Learning Styles test was executed and found to be almost identical on output.
- The same group of subjects was used to test both WISDeM's CP and LS psychometric tests. The results for the LS test gave the following:

Learning Styles	**Rating**
Do you consider that these **Learning Styles** match your own ideas?	9.50
Was this section easy to complete?	10.00
Did the report adequately reflect your input?	9.50
Overall was the sequencing well presented?	9.50
Overall did the Human Computer Interface act as expected?	9.50
Overall was the use of colour and presentation up to HCI standards?	9.50

Figure 43 – Learning Styles development test results

Exactly the same comments can be made concerning the small number of participants in the LS test as for the CP test. The results also provided significant results supporting the LS psychological test that, whilst not conclusive, are sufficiently significant to be able to move forward and be used in WISDeM.

5.3.1.5 Conclusion on CP and LS psychometric tests in WISDeM

- Both psychometric tests (CP and LS) were constructed with in-depth research, tested, validated and refined before being launched in WISDeM.
- Both have the same fragility of assessment and evaluation with only a few subjects.
- Both require further validation with a larger number of subjects.
- Both need validating against various dimensions (e.g. face validity, predictive validity, construct validity).
- The research needs to be robust and offer reliable, valid evidence and clear implications based on empirical findings. This requires both observational evaluation and self-testing comparative analysis.

With these reserves in mind the psychometric tests were used and, as reported in Chapter 8 - Evaluation, provided some significant results concerning improvement in subjects' remembering.

5.3.2 Initial Student Profile development

The 'Initial Student Profile flow chart' (see Pg.81 - Fig.29) shows the decision flow, report and storing of the initial Student Profile. The student is asked to complete the Communication Preference questionnaire by selecting only those statements with which he/she agrees. There are seven questions covering each of the three main sensory instance input to memory: the (V) visual memory, (A) auditory memory and (K) kinaesthetic (emotional/feelings) memory. The answers are evaluated, a report output and a link opens a Learning Styles questionnaire that is couched using the language pattern relevant to the student's Communication Preference.

The Learning Styles questionnaire asks ten questions, split into couplets, on the four sections:

Inter-personnel Communication	(E) Extrovert	(I) Introvert
Information Processing	(S) Sensing	(N) Intuition
Information Evaluation	(T) Thinking	(F) Feeling
Decision Style	(J) Judgement	(P) Perception

The resulting computer analysis selects one Learning Style profile out of the sixteen possible[40], reports on each section and provides an overall Learning Style summary. The student can either agree with the profile report or redo the questionnaire/s. If the student agrees with the Communication Preference and Learning Styles reports they are logged to the initial 'studentProfile' table in the database[41].

5.3.2.1 Abbreviated Communication Preference Algorithm - pseudo code

This abbreviated pseudo code illustrates the flow the system uses. The VAK variables are the counters that store the CP psychometric test answers as visual, auditory or kinaesthetic. The outcome stores V, A or K.

```
GET, validate and store User and School ID
Output Communication Preference questions
Initialise counters and VAK variables
WHILE input from answers exists
  Increment counters as relevant
IF total input is less than 7
  Output relevant message
ELSE
  Output relevant VAK report
Record Communication Preference for Learning Styles
```

5.3.2.2 Abbreviated Learning Styles Algorithm - pseudo code

This abbreviated pseudo code illustrates the flow the system uses. All questions are output using the relevant CP NLP language pattern. The type counters: E=extrovert, I=introvert, S=sensing, N=iNtuition, T=thinking, F=feeling, J=judgment, and P=perception. The LearningStyle is initialised = (""). The Learning Style is made up of four sections IC=interpersonal communication (E|I), IP=information processing (S|N), IE=information evaluation (T|F), and DS=decision style (J|P). Using one value from each couplet creates sixteen learning styles.

The relevant Learning Style is stored into temporary memory and reports are generated that cover the student's communication preference, learning styles and Jungian

[40] **Learning Styles**: ESTJ, ESTP, ESFJ, ESFP, ENTJ, ENTP, ENFJ, ENFP, ISTJ, ISTP, ISFJ, ISFP, INTJ, INTP, INFJ, and INFP

[41] **studentProfile**: University Registration Number, University School, Communication Preference and Learning Styles

functions. Upon acceptance of these the CP and LS are stored in the initial Student Profile data table.

```
GET Communication Preference (VAK)
  Select and output relevant NLP Language Pattern questions
IF answers not complete
  Output relevant error message identifying section shortage
ELSE
  Initialise type counters (E,I,S,N,T,F,J,P) & LearningStyle
  WHILE input data exists
     Increment type counters
  Select and store relevant Learning Style for each section
  Store predominant Learning Style (1:16)
  Output comparative analysis for each section (IC:IP:IE:DS)
  Output predominant Learning Style
  WHILE data for Section exists
    Select SPECIFIC message for answer
    Output a combined report for section answers
  Select SPECIFIC Learning Style messages for each section
  Output a combined Learning Style report for section
  After acceptance by the student
  STORE Communication Preference and Learning Styles in initial
    Student Profile
```

5.4 Development of Communication Preference questions

Research (Bandler, 1985; Bandler & Grinder, 1990; C Ghaoui & Janvier, 2004a; William A. Janvier & Ghaoui, 2003b; Lai, 1993; Sadowski & Stanney, 1999) indicates that communication is enhanced when the inter-personnel communication evokes the preferred Communication Preference (CP) using Language Patterns (see 3.2.2 - Pg.64 - NLP Language Patterns).

(N. Fleming, 2002; N. D. Fleming & Mills, 1998) both provide in-depth analysis of VARK, the Visual, Auditory, Read/Write, Kinaesthetic and Multi-modal applicant preferences, and also provide excellent details, examples of specimen questions and reports for all sections. These principles have been applied to produce the twenty-one VAK questions used in the CP questionnaire (see Fig.44).

Each section has seven questions that are specifically related to the student's sensory perception; for example for (V) *"I prefer a lecture to be illustrated with slides"*, for (A) *"I like music more than art"*, and for (K) *"When I recall an experience, I usually remember how I felt about it"*. These questions are mixed and the student is asked to only select those statements with which he/she agrees. After selection his/her choice is analyzed and a pertinent report output. The student's own CP Language Pattern is used for the Learning Styles questionnaire.

Type	Question
A	When I recall an experience, I usually remember the sounds I heard.
A	When I am alone, I like to have music playing or hum or sing.
A	I find that it is easy to remember conversations I have had.
A	I like music more than art.
A	I sit towards the front of a lecture room so that I can easily hear what is being said.
A	Without music, life isn't any fun.
A	I know most of the words of the songs I like.
K	When I recall an experience, I usually remember how I felt about it.
K	When someone is talking to me about something, I easily feel emotional.
K	I usually say things like, "I feel, I need to understand it first."
K	I usually think carefully about what I am saying to make sure that I can express my feelings.
K	When I read a story, I usually get emotionally involved with the characters.
K	If I think about the last time I was out with friends, I can easily remember how it felt.
K	I feel comfortable in social groups and find it easy to talk to strangers.
V	When I recall an experience, I usually picture it in my mind.
V	I prefer to read a story rather than listen to it on a tape.
V	I prefer a lecture to be illustrated with slides.
V	Whilst I am talking, I often describe what I have seen and picture what I am being told.
V	When I am going somewhere, I can usually picture in my mind how to get there
V	If I am buying something to go in my room, I usually find that I can see how it will fit in.
V	I can usually tell directions, like north and south, no matter where I am.

Figure 44 - VAK questions

5.5 Development of Learning Styles questions

The Learning Style questions were developed using the MBTI® principles and style with five pairs for each learning style[42] some with obvious opposites and some designed to be close. Each set of questions has been replicated using the three language patterns: for example for **(V)** "*I notice that I tend to talk more than I listen*", for **(A)** "*I tend to talk more than I listen*" and for **(K)** "*I feel that I tend to talk more than I listen*" and

[42] **learning style** - *Inter-personnel Communication* (Extrovert/Introvert), *Information Processing* (Sensing/Intuition), *Information Evaluation* (Thinking/Feeling) and *Decision Style* (Judgement/Perception)

presented to the student according to his/her Communication Preference. Provided all sections are answered, the report is complied of:

- 4 sections of 5 answers selected as relevant for each answered question.
- An overall Learning Styles Summary (see Fig.45) produced reflecting the dominant learning style for each of the 4 sections: each is colour coded.

The Communication Preference and Learning Styles are logged to the database to enable the relevant styles to be coordinated.

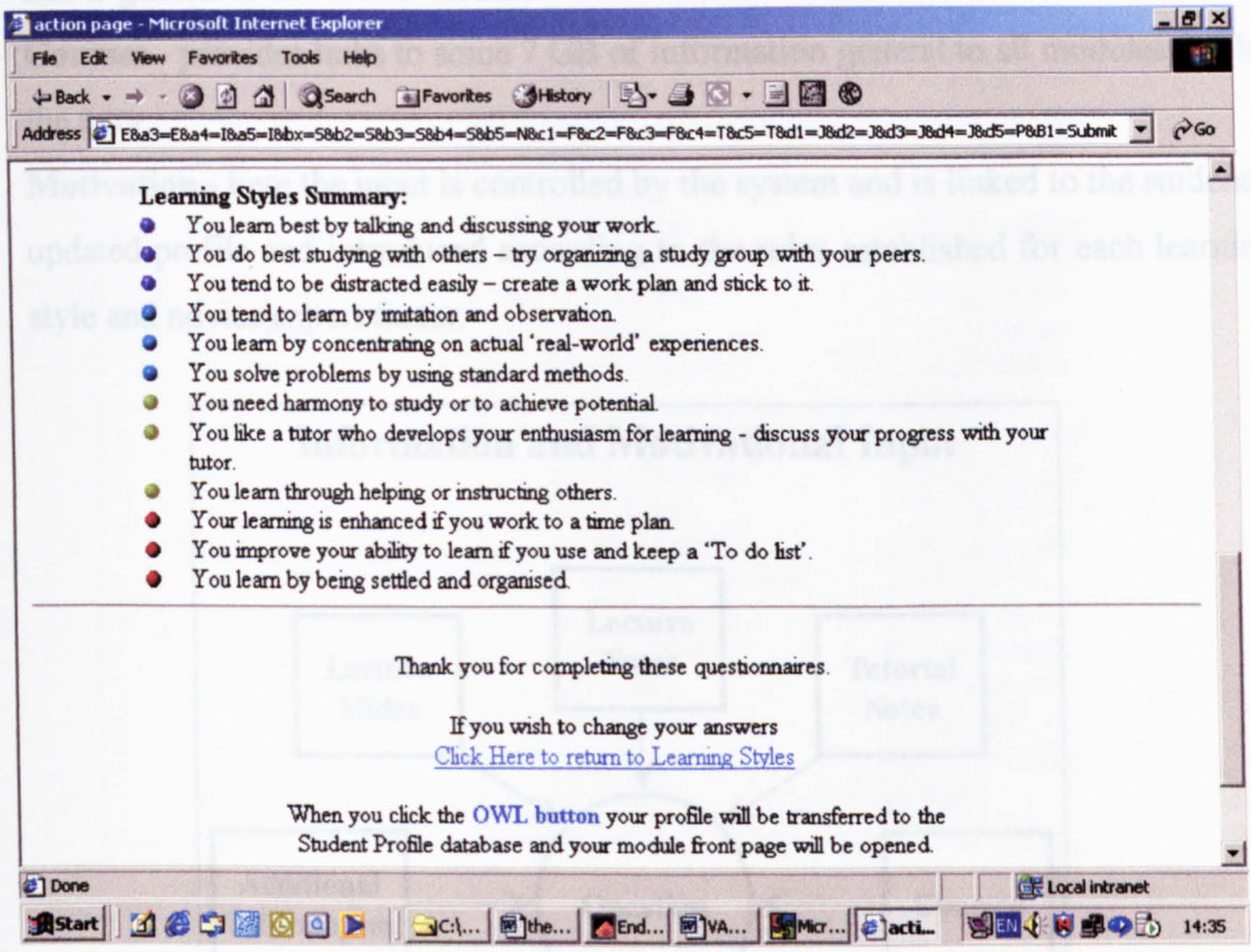

Figure 45 - Sample Learning Styles summary report

5.6 Question Knowledge and Motivation input

Knowledge and motivation sources in WISDeM are drawn from a number of sources mainly controlled by the tutor, whilst motivation is embedded in the system (see Fig.46). Thus the tutor maintains control over pedagogical input and the questions/answers used in the interactive Q&A section. Here the system adds the relevant motivational and reward messages and controls how the information is output.

- **Lecture Slides** - weekly lectures are presented often supported by overhead slides or PowerPoint presentations that are specific to each weekly lecture.

- **Lecture Notes** - are detailed, more in-depth documents that are related to each specific weekly lecture
- **Additional Information & Useful URLS** - is available for each specific weekly lecture including specific WWW links that are general to the whole module.
- **Tutorial notes** - are available for each specific weekly tutorial or lab session and provided more in-depth coverage.
- **Resources (course book/s)** - provides a listing of books and links to information that is general to the whole module
- **Courses** - provides links to some 7 GB of information general to all modules run by the tutor.
- **Motivation** - here the input is controlled by the system and is linked to the student's updated profile and introduced according to the rules established for each learning style and novice|expert factor.

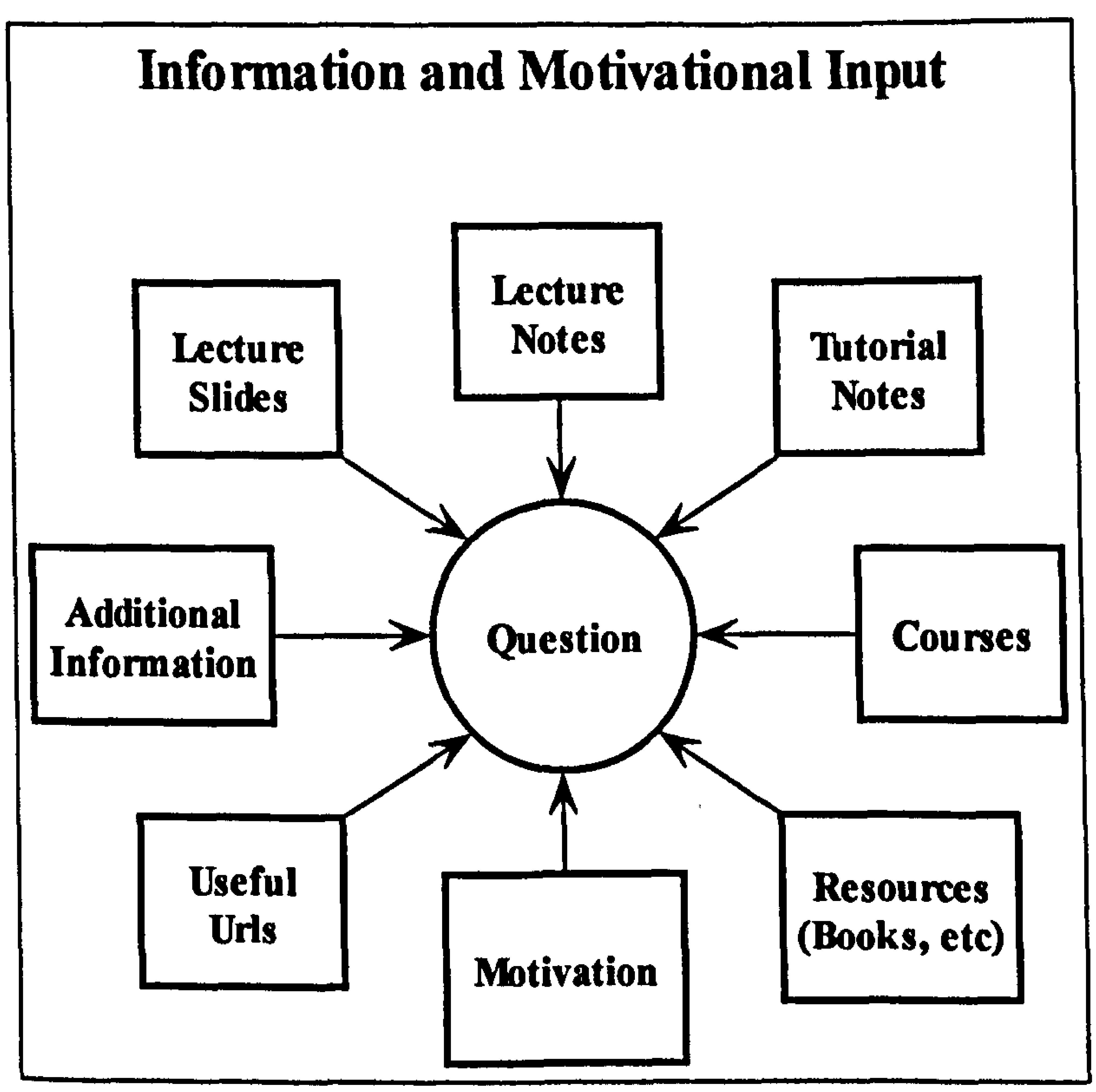

Figure 46 - Knowledge and Motivational Sources in WISDeM

Knowledge Identification occurs in differing manners according to where it is stored (see Fig.47).

In the main system server the HCI data is stored in the **WISDeM** cmsHci folder courses, information, and module (labSession and lecture): these links connect to the servers holding 'wisdemTutor' and 'courses'. **WISDeM Tutor** main information sources are information (general) and module (e.g. mod01 - addInfRes, information (specific to the module/week)), lecture (notes and presentation specific to the module/week)). **Courses** hold some seven Gigabytes of additional information that is general to all modules.

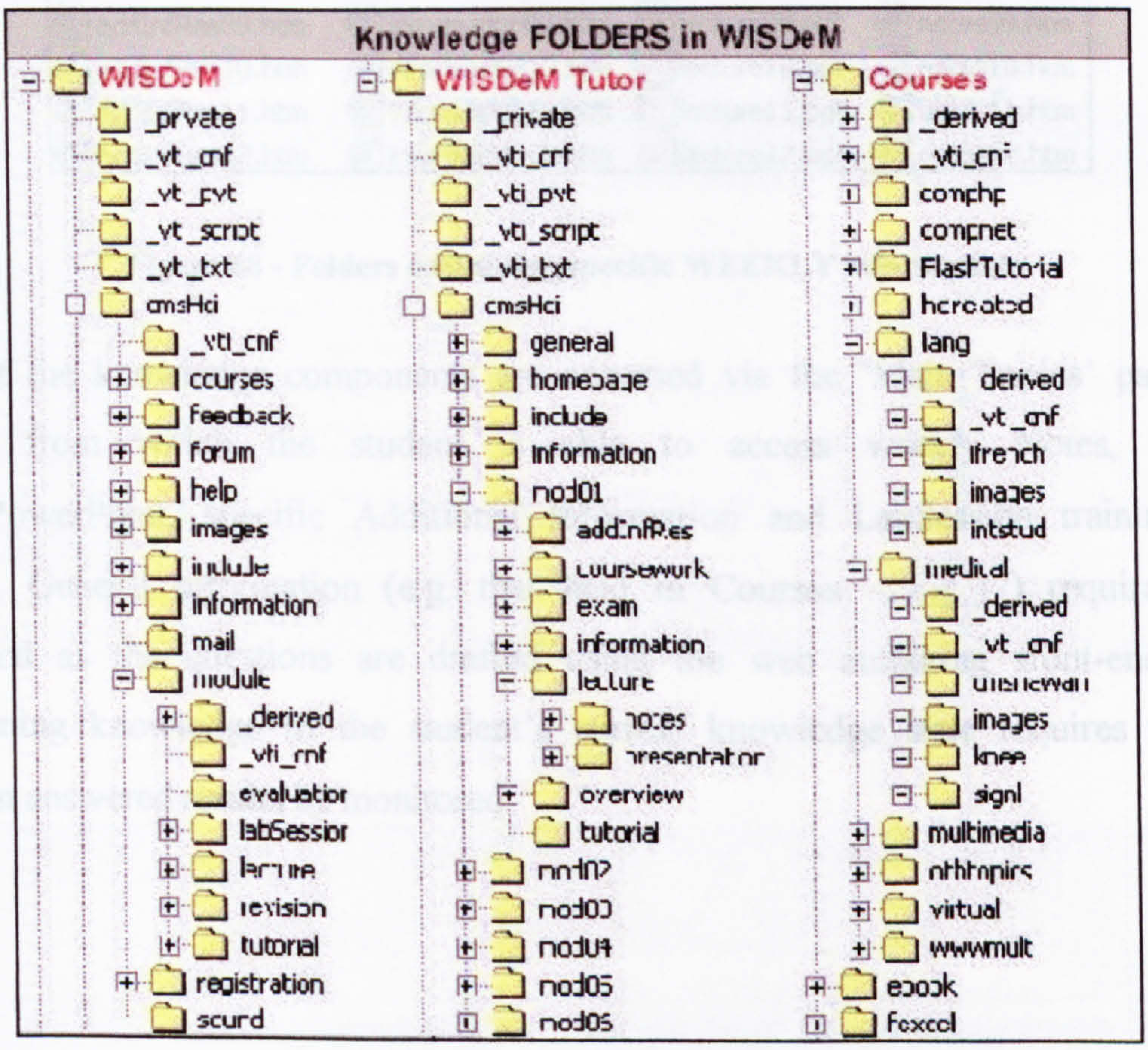

Figure 47 - Knowledge Folders in WISDeM

Thus it is possible to identify information on which the questions are drafted to the week's folder information in the relevant data tables without reference to the tutor or author (see Fig.48).

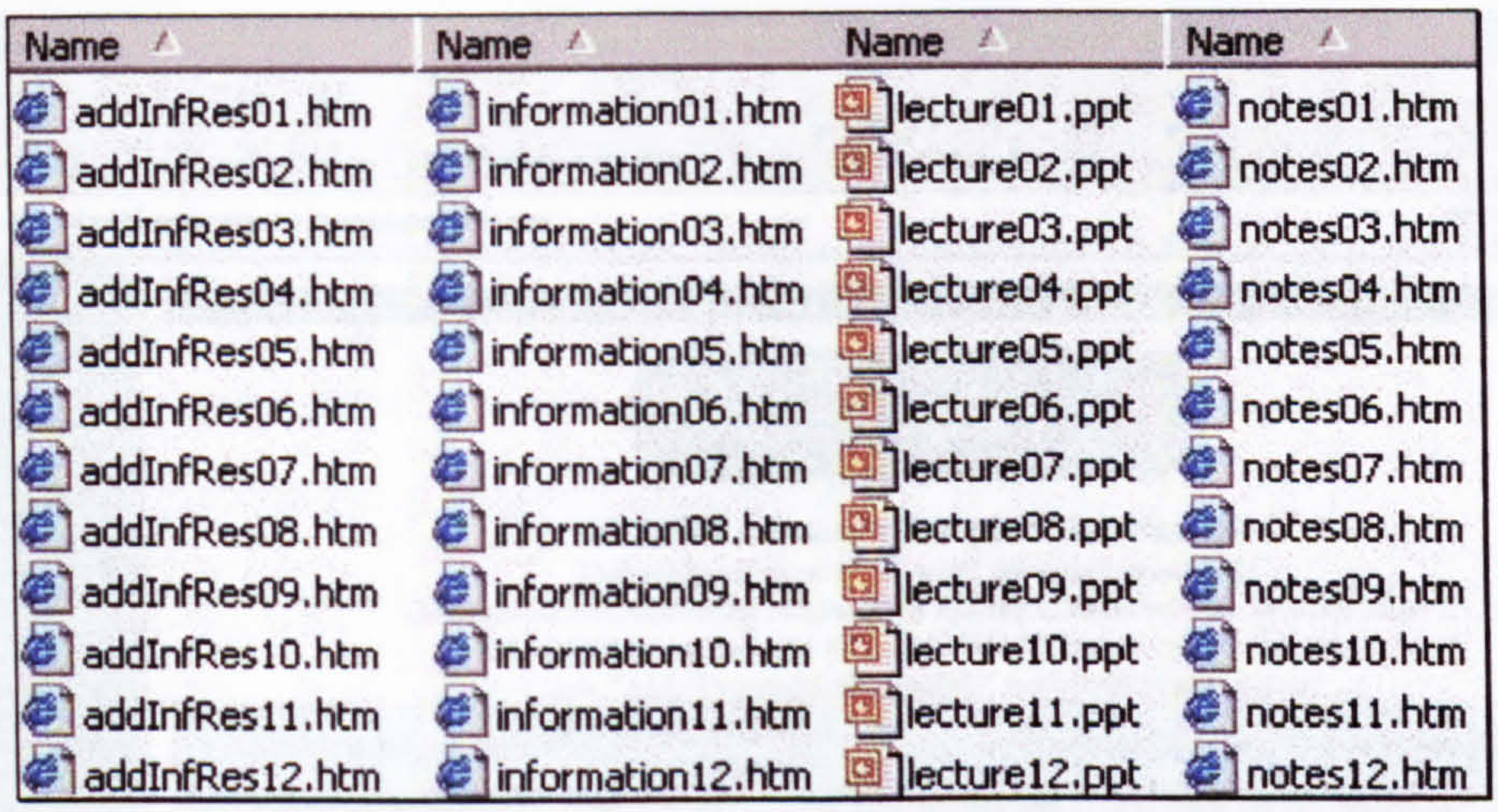

Figure 48 - Folders containing specific WEEKLY information

Most of the knowledge components are accessed via the 'Main Topics' page (see Fig.49) from which the student is able to access weekly Notes, Lecture Slides/PowerPoint, specific Additional Information and LabSession training (see Fig.50). General information (e.g. that held in Courses – Fig.47) requires links generated as the questions are drafted using the web authoring front-end. Thus maintaining knowledge of the student's current knowledge state requires that the question answered results be monitored.

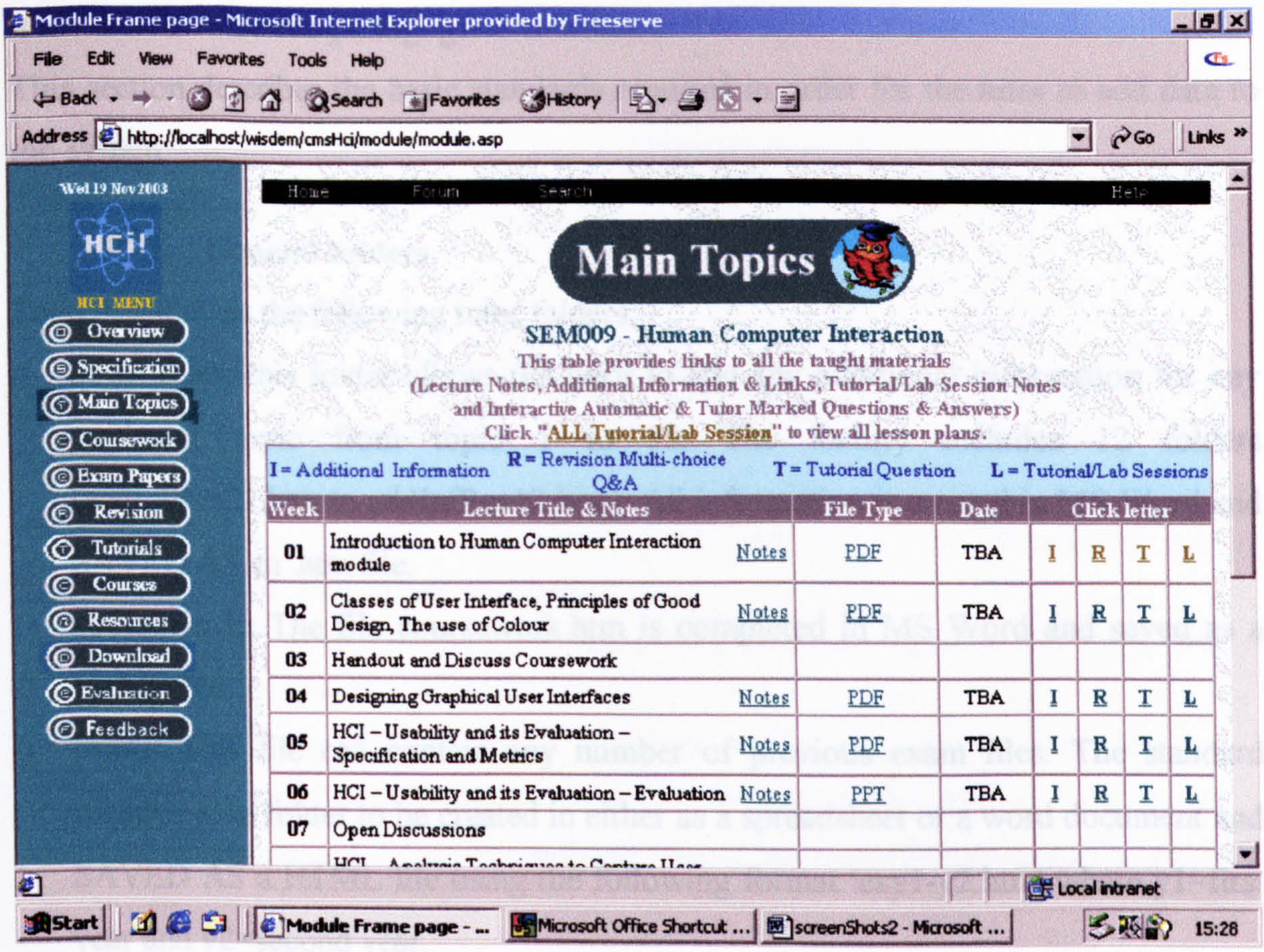

Figure 49 - Main Topics page

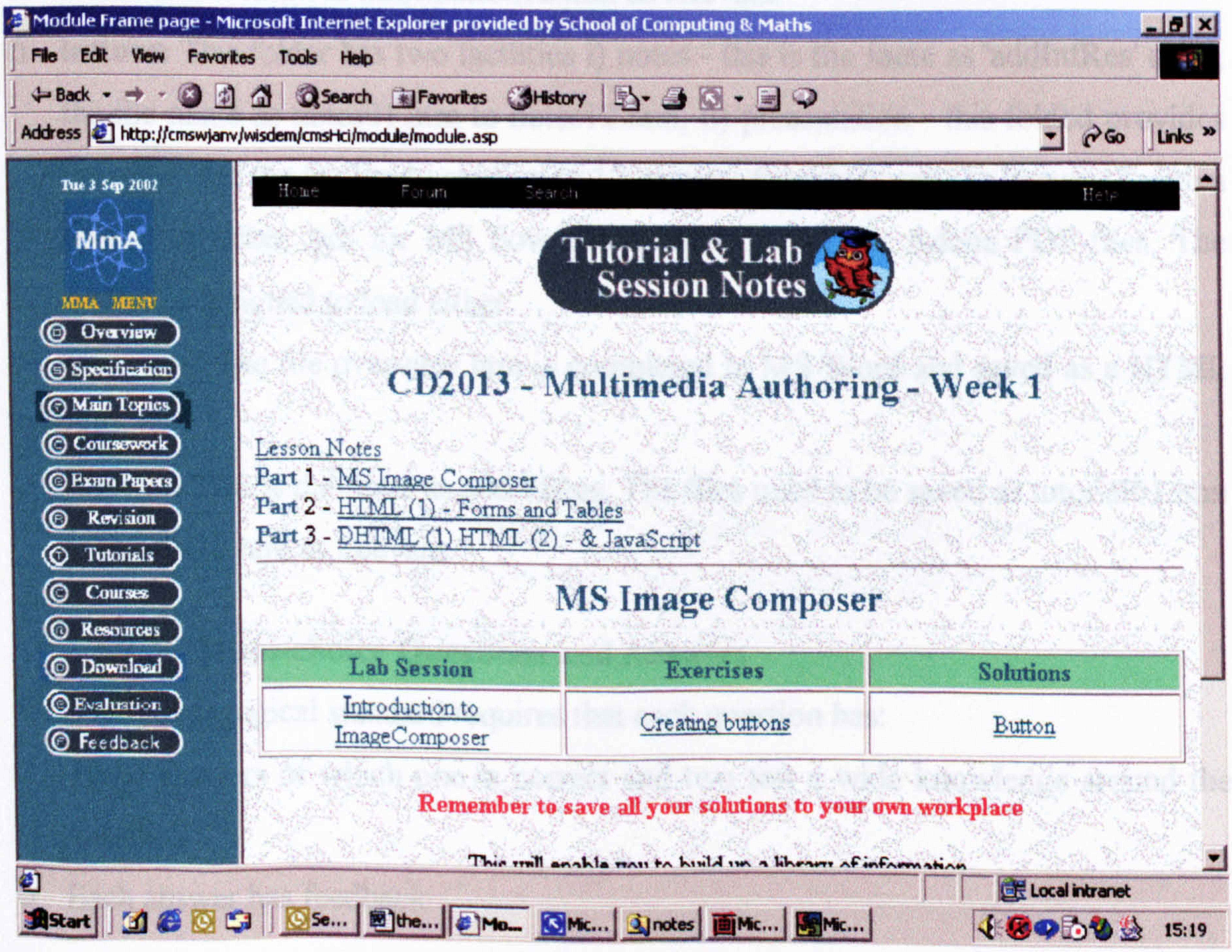

Figure 50 - A LabSession information page

5.7 WISDeM's pedagogical standards

This section describes the basic standards required in order for the tutor to add data to the system.

5.7.1 General folders

Each module has the following tutor folders:

- **addInfRes:** this folder allows the tutor to add any additional information for any particular topic from topic 1 to 12. The facility includes 12 folders (addInfRes01.htm to addInfRes12.htm). All information is created in MS Word and SAVED AS an .htm file.
- **coursework:** The file coursework.htm is completed in MS Word and saved as a HTML file.
- **exam:** This file can contain any number of previous exam files. The standard requires each folder to be created in either as a spreadsheet or a word document and SAVED AS a HTML file using the following format 'exy1-y2.htm' where y1=first year and y2=second year.
- **information:** This is the same as addInfRes. The files need to be saved as information01.htm to information12.htm as relevant.
- **lecture:** This folder has two facilities i) notes - this is the same as 'addInfRes' using the file name as notes01.htm to notes12.htm, ii) presentation - this folded provides the tutor with the facility to save up to 12 lectures from lecture01 to lecture12 with a postfix of either .pdf for MS PowerPoint files or .pdf for Adobe PDF files. The system is designed to load either.
- **overview:** The file overview.htm is completed in MS Word and saved as a HTML file.
- **tutorial:** This is the same as addInfRes. The files need to be saved as tutorial01.htm to tutorial12.htm as relevant.

5.7.2 Multi-choice Questions and Answers

WISDeM pedagogical standard requires that each question has:

- Three answers of which one is correct and two test a wide knowledge around the question.
- Each answer has feedback.

- Each question has a source bibliography where the student can obtain further information
- Where relevant, each question has a diagrammatic, illustration, slide reference, especially if one was used in the lecture.

For example the question:

`Q121 Human Computer Interaction can be defined as:`

- Has three linked answers:

  A177 The discipline concerned with the design of interactive computing systems for human use and with the study of major phenomena surrounding them.

  A178 The study of people, computer technology and the ways these influence each other.

  A179 A multidisciplinary science made up of computer science, psychology, linguistics, ergonomics and sociology.

- Each answer has a linked feedback where the words incorrect and correct are posted by the system:

  A177 **INCORRECT** - *The discipline concerned with the design, EVALUATION & IMPLEMENTATION of interactive computing systems for human use and with the study of major phenomena surrounding them.*

  A178 **CORRECT** - *This is the interaction between the computer and user.*

  A179 **INCORRECT** - *This needs to include the relevant stakeholders (users, educators, designers) not just the science.*

- There are two bibliographical links:

  Christine Faulkner, 1998, *The Essence of Human-computer Interaction (Essence of Computing)*, Prentice Hall, p. 207, ISBN 0137519753

  Dix A., Finlay J., Abowd, G., Beale, R, 1998, *Human Computer Interaction*, 2nd ed, Prentice Hall, p. 649, ISBN 0132398648

A lecture slide was used (see Fig.51).

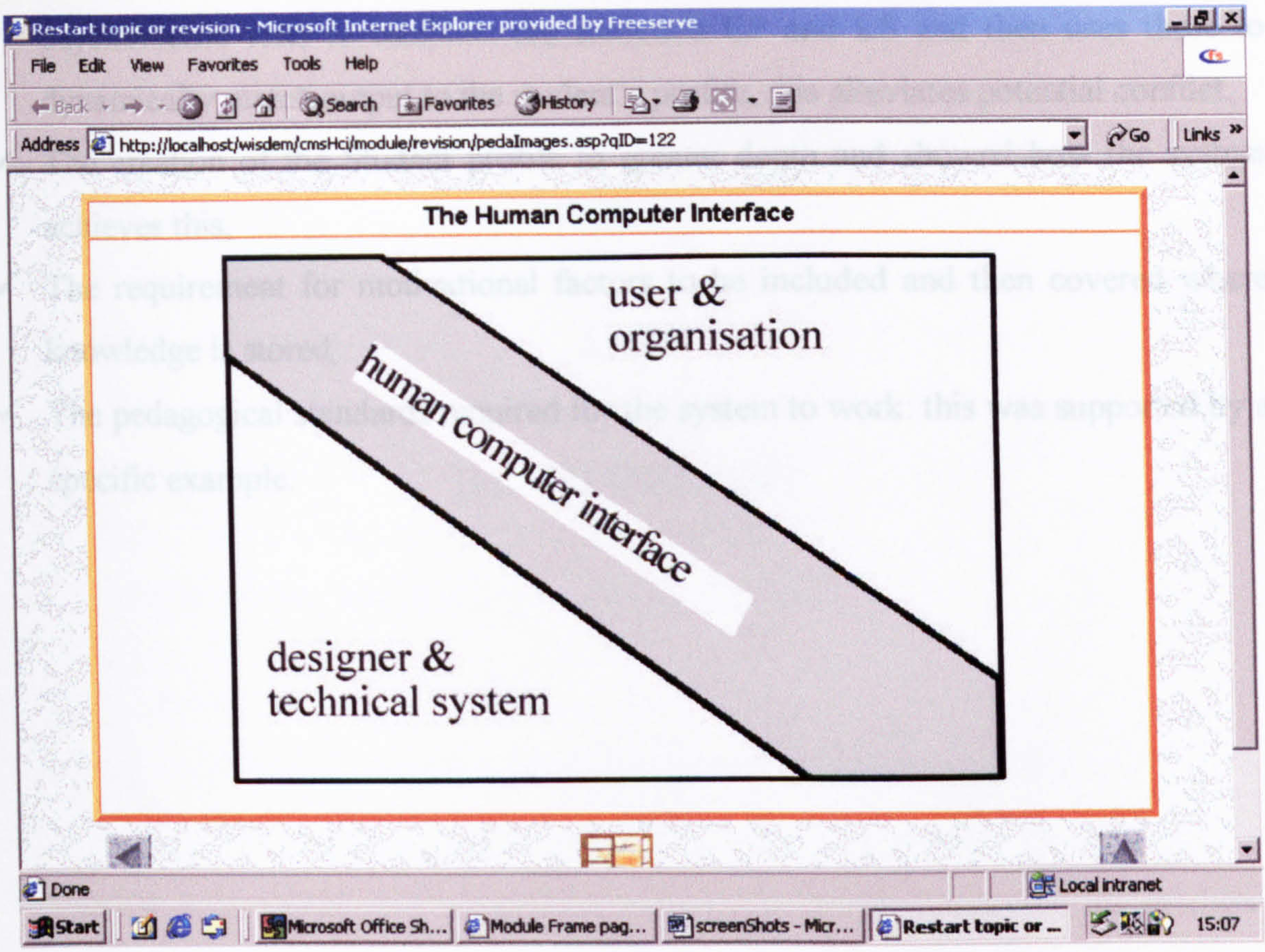

Figure 51 - What is HCI - lecture slide

5.8 Chapter Summary

This chapter discussed Student Learning Styles and Teaching Styles, it then went on to describe in depth the Student Profile and the initial Student Profile Model, the way the CP and LS questions were validated, outlined some reservations and limitations, and expanded on CP and LS by providing the basic pseudo code for both.

Then the chapter discussed in some depth the development of the CP and LS psychometric tests that were based on in depth research on VARK and MBTI® concepts and principles. It covered the Student Profiling evaluation that occurred whilst the system was being built and the successful evaluation results (see Chpt.8 - Pg.219 - Evaluation)

It looked at Question Knowledge and Motivation and highlighted the source and responsibility for creating and storing knowledge.

Briefly this chapter discussed:

✓ The importance of using learning styles: the student has his/her own preferred way of learning, the teacher has his/her own way of teaching, the system uses two psychometric tests to establish the student's CP and LS and then uses these to dynamically match output to the student's profile, this alleviates potential conflict,

- ✓ The creation of the Student profile to greater depth and showed how the system achieves this,
- ✓ The requirement for motivational factors to be included and then covered where knowledge is stored,
- ✓ The pedagogical standards required for the system to work: this was supported by a specific example.

CHAPTER 6

DESIGN

AND

DEVELOPMENT

6 Design & Development

This chapter provides a detailed account of the way WISDeM has been designed and developed. It covers the:

- Implementation time scale,
- Basic Design Concepts,
- The use of the five principles of good design
- System and Development Tools used,
- Design and Development in years one and two,
- Design and Development in year three onwards.

6.1 Introduction

The design and development has been spread over four years: the first year saw the creation of a basic specifically designed facility with database linking. Over the next three years substantially more sophistication was added culminating in the inclusion of the intuitive intelligent section that matches CP and LS. Basic standards were initiated at the beginning; however, substantially more ingenuity was added from year two where in-depth reusability was introduced and the system turned from being specific to generic.

This chapter also highlights how the 'five principles of good design' (Naturalness, Consistency, Non-redundancy, Supportiveness, and Flexibility) have been incorporated into the design: it provides specific examples. The chapter then provides details of the system and development used both to create and run the system.

Finally a detailed account is provided of the design and development for years one and two, the Core Distance Learning Section, and for year three onwards, the Intuitive Interactive section of the system and the administrative system. During these phases 'Force-Field-Analysis' was continually used and incorporated with a 'Wizard of Oz' approach and 'Cooperative Evaluation' during the design stage. As the system was being implemented both 'Cognitive Walkthrough Evaluation' and 'Brainstorming' were adopted and finally, as relevant, 'Observational Evaluation' was introduced (see Chpt.8 - Pg.219 – Evaluation - for depth on these methods).

6.2 Design & Development time scale

Figure 50 outlines the systems structure and size.

The system has been developed over four years as follows:

- **Year 1** - much of the basic coding for a DLT contained in 'cmshci' and original files for 'wisdemTutor' that were contained within 'cmshci' were developed. Also developed at this time was a basic database.
- **Year 2** - the basic coding in 'cmshci' was amended to turn the system from a specific type to a generic type and saw the start of 'wisdemAdmin', 'wisdemImages', 'wisdemInclude' and 'wisdemTutor'. A more sophisticated database was developed.
- **Year 3** - system development was continued.
- **Year 4** - the intuitive interactive section within 'cmshci' and the sections 'wisdemCPLS', 'wisdemAdminAI' were developed together with the database-required development. Fig.52 shows the finished structure.

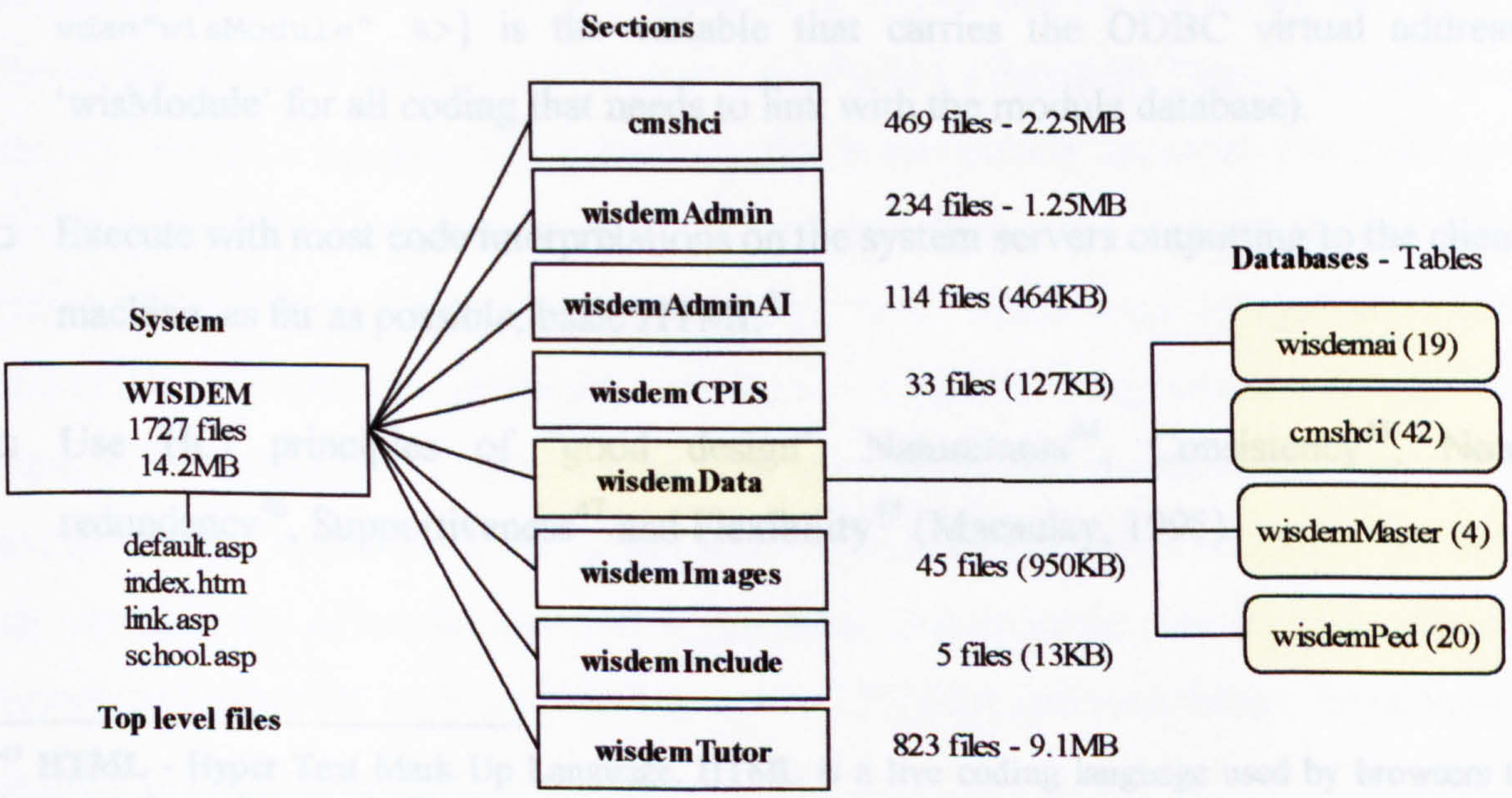

Figure 52 - WISDeM System - Sections - Databases

6.3 Basic Design Concepts

The following concepts were used in the development of WIDSeM:

- Use KISS - 'Keep-It-Simple-Stupid' - as the English philosopher, William of Occam (1300-1349) suggested *"Entia non sunt multiplicanda praeter necessitatem"* (Entities should not be multiplied more than necessary) (Beckett, 1994).

To ensure that the system can be viewed as a KISS development, the interface is intuitive to use with a consistency that ensures that every screen has the same information in the same place.

The system is also colour coded which means that the user soon becomes aware of the fact that the same background colour is being used for the same class of information.

All hyperlinks are hierarchical in nature.

Where the user wants additional information that expands on the current screen, new windows open with prominently displayed 'close window' buttons.

In addition the coding has used reusable code as far as possible (e.g. ODBC data links are created by variables where the database virtual address needs to be changed at the upper coding level to change all sub-pages {ASP code `<% vda="wisModule" %>`} is the variable that carries the ODBC virtual address 'wisModule' for all coding that needs to link with the module database).

- Execute with most code interpretations on the system servers outputting to the client machine, as far as possible, basic HTML[43].
- Use HCI principles of 'good design': Naturalness[44], Consistency[45], Non-redundancy[46], Supportiveness[47] and Flexibility[48] (Macaulay, 1995).

---

[43] **HTML** - Hyper Text Mark Up Language, HTML is a live coding language used by browsers to interpret the coding used. The browser interprets each page as it is loaded and then remains static. HTML does not carry-forward information or allow any changes to a page once it has been loaded.

[44] **Naturalness** - Natural dialog that does not cause the user to significantly alter his/her approach to the task in order to interact with the system - this covers Guidelines providing ordering of tasks for user, Use of language, User jargon, Self explanatory terms, Use of standard terms/abbreviations, Not over friendly.

[45] **Consistency** - Consistent dialog ensures that the user gains knowledge of the system that is not frustrated by changes in the conventions used in another part of the system - this covers Phrasing, use of words should always have the same effect, Format, Layout, Error Messages, Highlighting and Colour should all be consistent.

[46] **Non-redundancy** - Non-redundant dialogue that requires user to input only the minimum amount of information - this covers Derived input if possible, Use of default values, Output not to be redundant, and Not displaying too much information on a page.

[47] **Supportiveness** - Supportive dialogue that gives user assistance to perform the task and running the system - this covers Quality and quantity of instructions should be geared to user requirements, Error messages should be clear and directional, and System should confirm what it is doing.

- Execute 'Force Field Analysis' and 'Risk Analysis' throughout and use constant evaluation and planning relevant to the design stage: i) Design Stage – Brainstorming, Story-boarding, Observation in the workplace, and Wizard of Oz, ii) Early Prototyping – Expert Walkthrough, and Co-operative Evaluation iii) Advanced Prototyping – Co-operative Evaluation, Interviews, and controlled experiments, and iv) Delivery Stage – Observation in the Workplace

6.4 The use of the Five Principles of Good Design

Throughout all pages of WISDeM the 'Five Principles of Good Design' (Macaulay, 1995) were used. The following discusses this aspect of the Design and Development.

6.4.1 Naturalness

Natural dialogue does not cause the user to significantly alter his/her approach to the task in order to interact with the system - this covers Guidelines providing ordering of tasks for user, Use of language, User jargon, Self explanatory terms, Use of standard terms/abbreviations, and Not over friendly. It is argued that, in the Interactive Multi-choice Question and Answer section (see 7.4 - Pg.211 - Revision Topic Learning and see 7.5 - Pg.213 - Revision Topic Testing), this is particularly apparent. The pages use the student's own Communication Preference and thus make interaction that more meaningful and easy. He/she does not need to convert textual input to a preferred type due to the subliminal text messaging (see Pg.61 - Iconic Memory) that has directed the input to the correct cortex for decoding. The use of language is natural and jargon free except where it is specific to the subject matter under review. Abbreviations, were used, are standard and abbreviations well highlighted. For example: see Pg.113 - Fig.49, where the linking for each topic facility uses a LETTER and each letter's functionality is listed in the table header.

6.4.2 Consistency

Consistent dialogue ensures that the user gains knowledge of the system and is not frustrated by changes in the conventions used in another part of the system. This covers Phrasing, use of words having the same effect and meaning, Format, Layout, Error Messages, Highlighting and Colour are all consistent. These are all followed in

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[48] **Flexibility** - Flexible dialogue that caters for or tolerates different levels of user expertise - this covers Catering for different levels of expertise at all levels of the dialogue.

WISDeM; however, variance has been introduced to provide the user with consistency in sections. For example:

- All additional information pages open in a new window and have their own format and background colour.

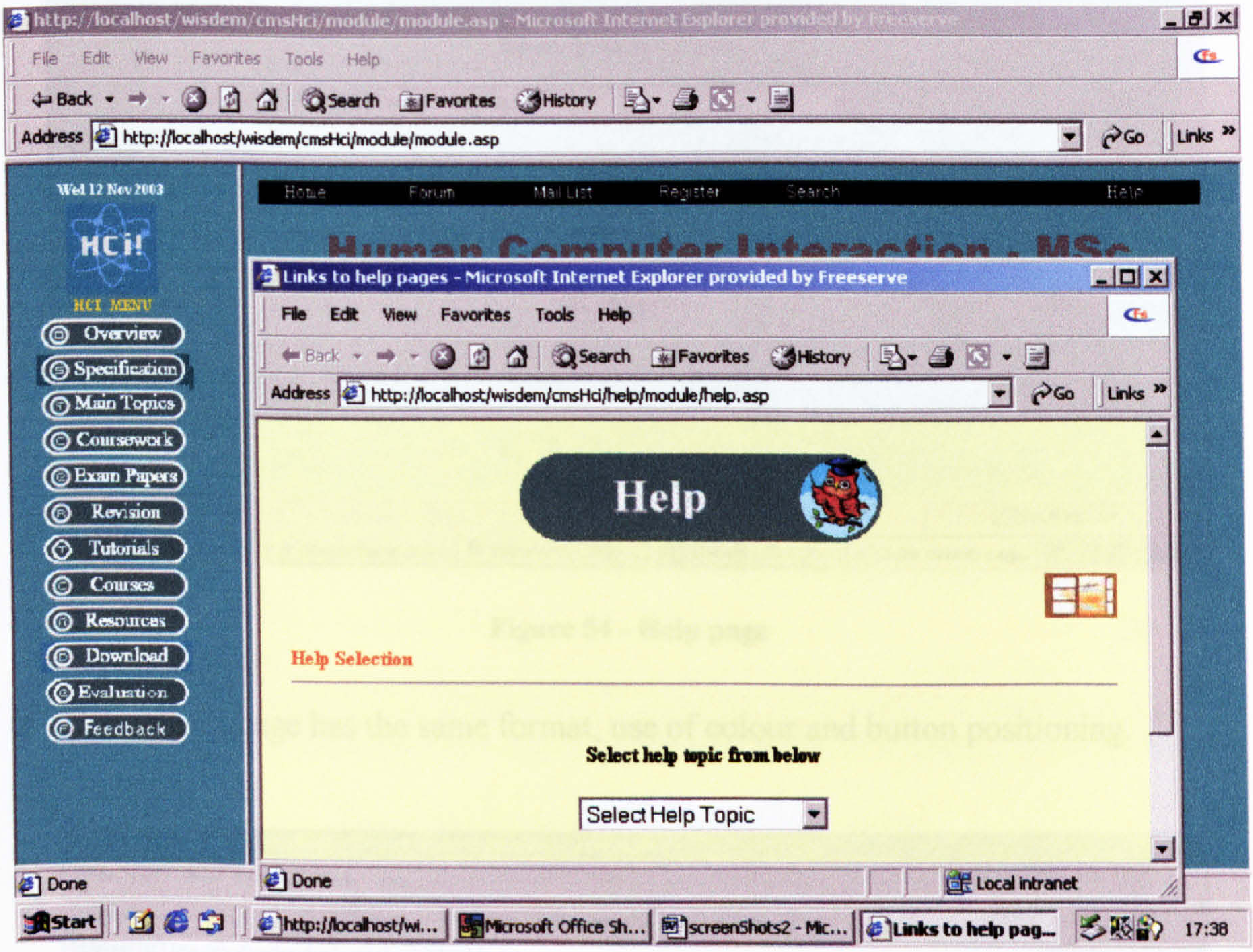


Figure 53 - Module Help facility

Fig.53 pages use yellow and Fig.54 pages use green.

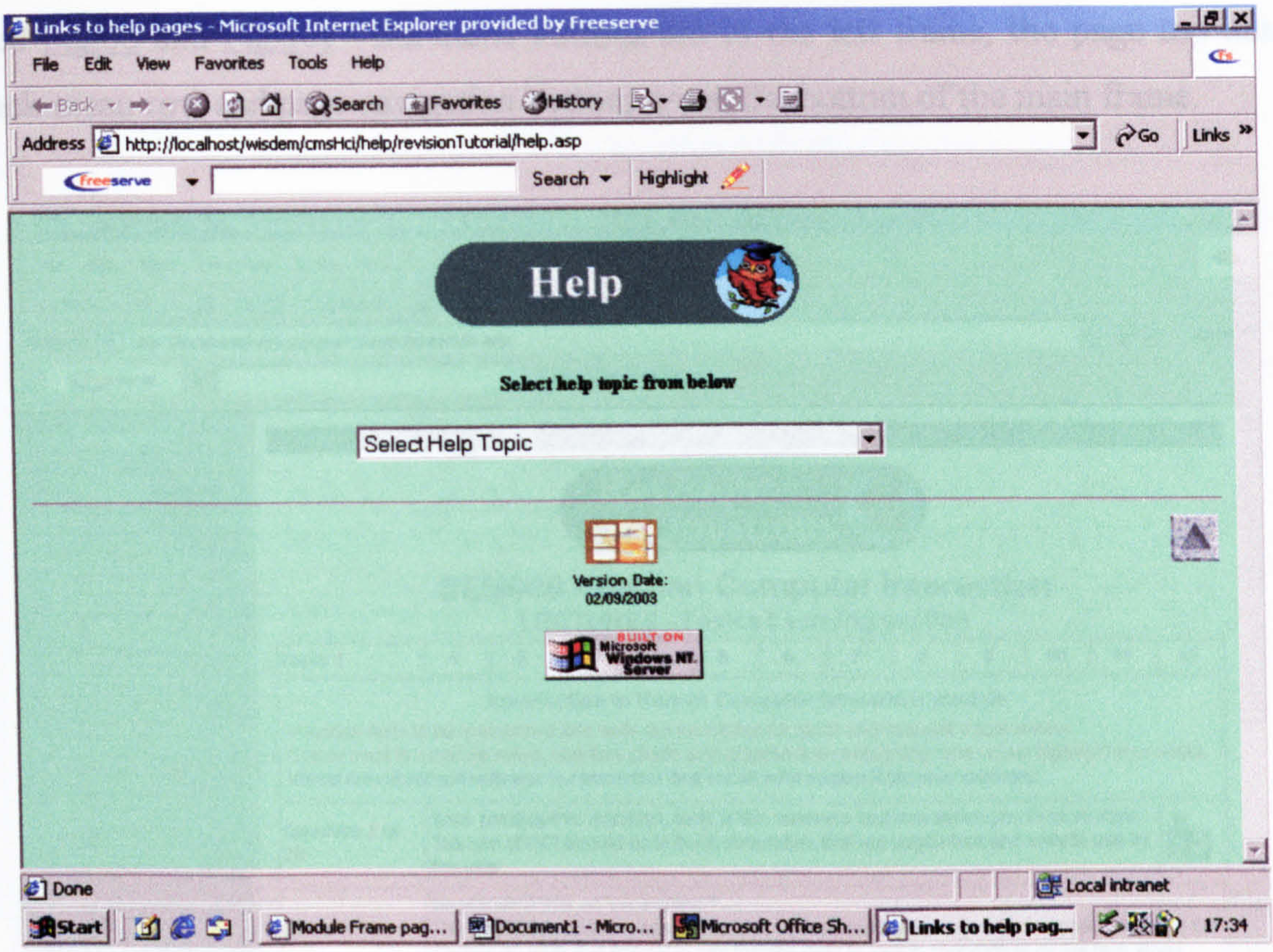


Figure 54 - Help page

- Every main page has the same format, use of colour and button positioning.

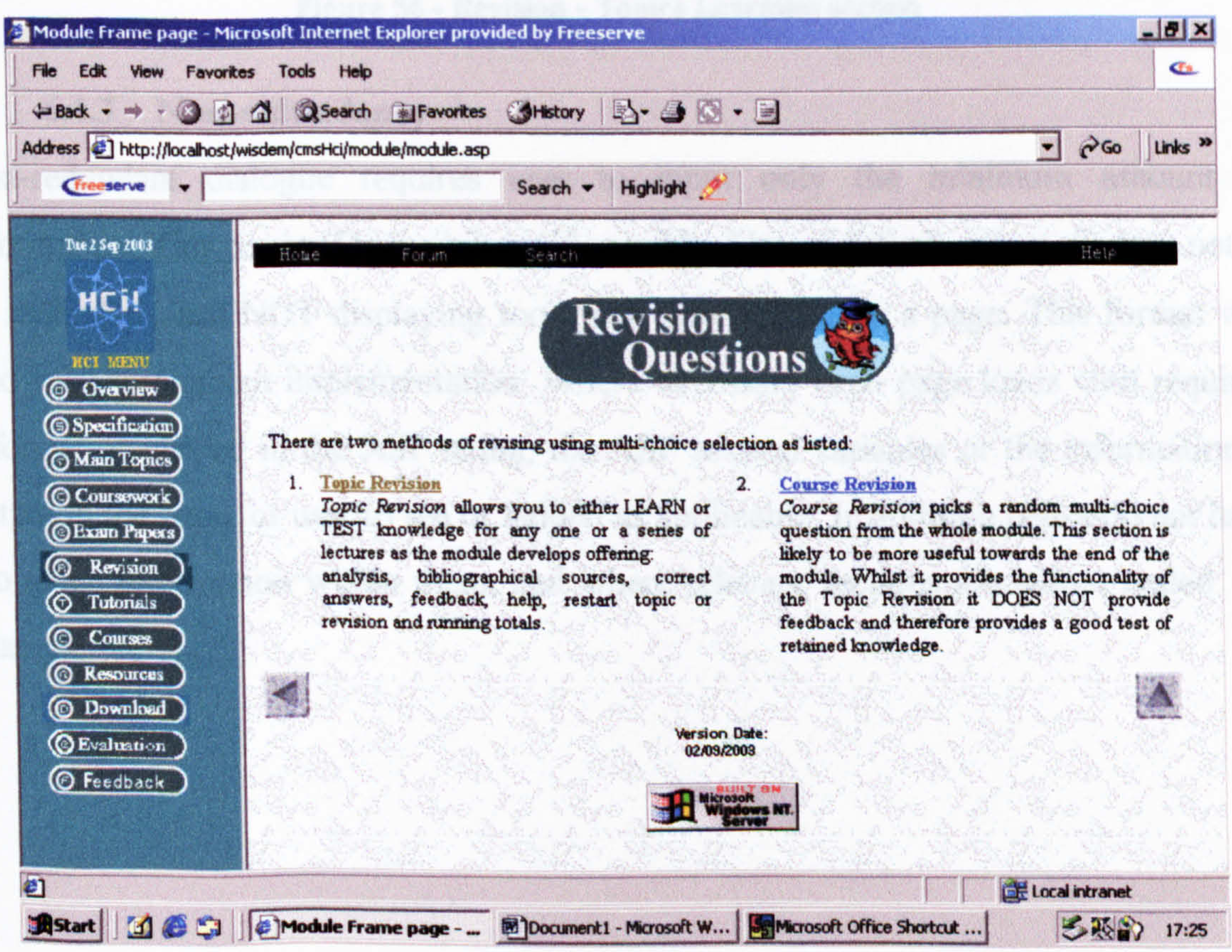


Figure 55 - Screen shot of Topic Revision | Course Revision

(See Fig.55 and Fig.56) - the menu buttons are in the left frame, the page top has a black menu row and page navigation buttons are at the bottom of the main frame.

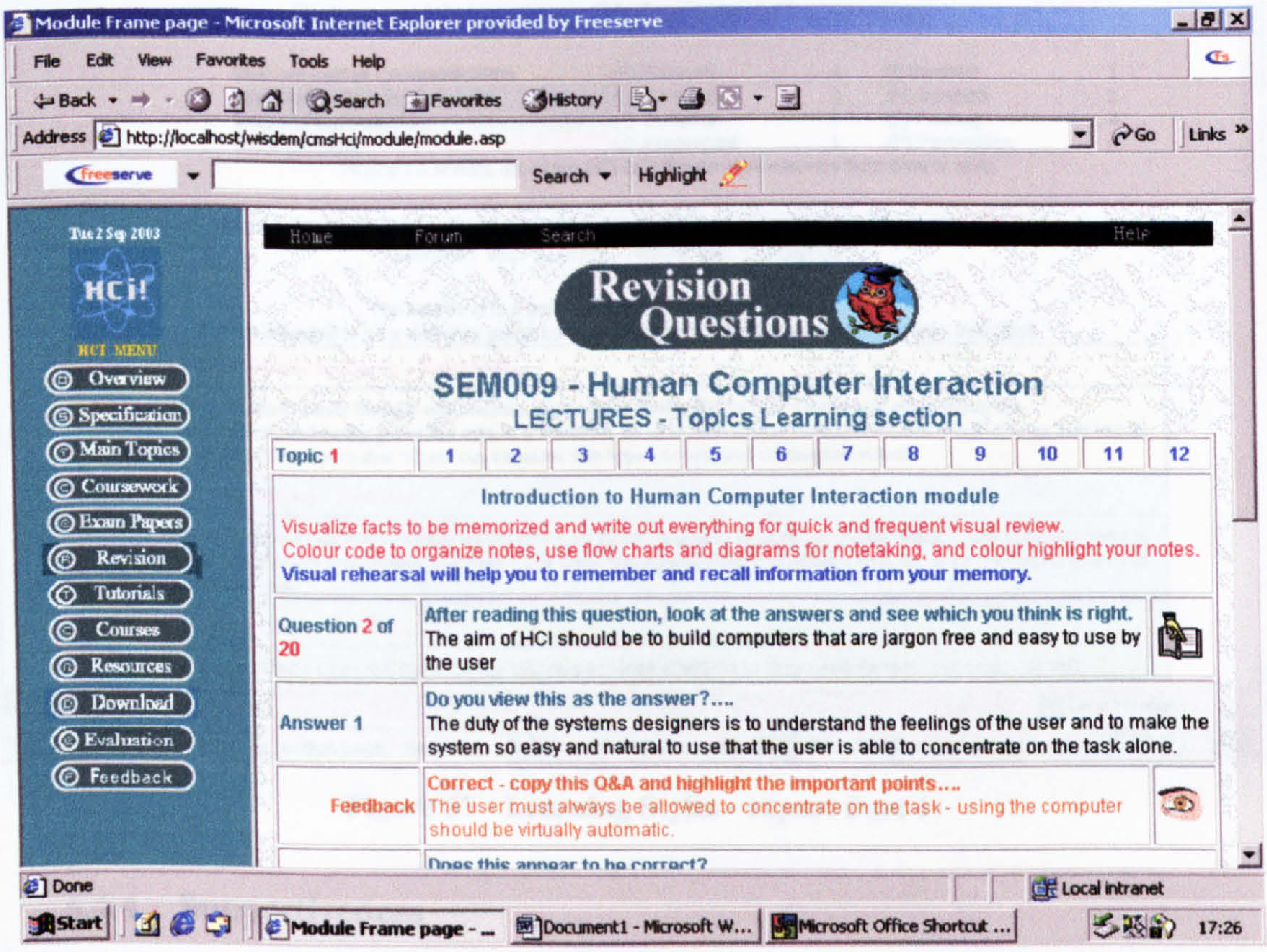


Figure 56 - Revision - Topics Learning section

6.4.3 Non-redundancy

Non-redundant dialogue requires user to input only the minimum amount of information. This covers Derived input if possible, Use of default values, Output not to be redundant, and NOT displaying too much information on a page. This format was also used throughout implementation. Where necessary each page loads with required information carried in the ASP string, the ASP session variables or the information is output to the page for user to see or hidden as applicable. In addition pages do not have too much information within them, and where relevant sections are colour coded: for example see Fig.57.

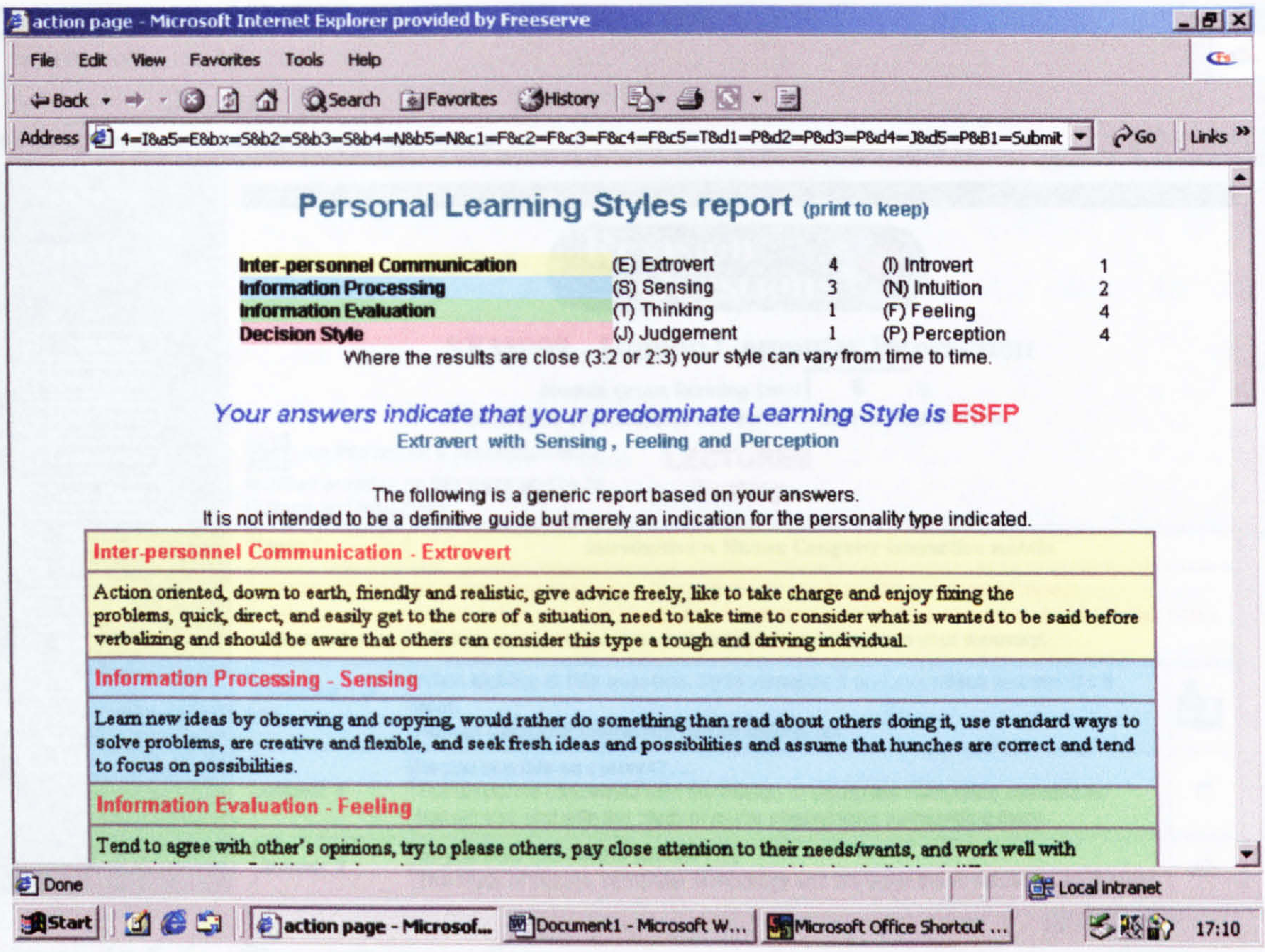


Figure 57 - Learning Styles - report Part 1

6.4.4 Supportiveness

Supportive dialogue provides the user with assistance to perform the task and run the system - this covers Quality and quantity of instructions that should be geared to user requirements, Error messages should be clear and directional, and System should confirm what it is doing. This is particularly relevant and used in the interactive multi-choice topic testing question and answer pages and in the feedback provided.

(See Fig.56 and Pg.180 – Fig.106, and Pg.129 – Fig.60 & Fig.61)

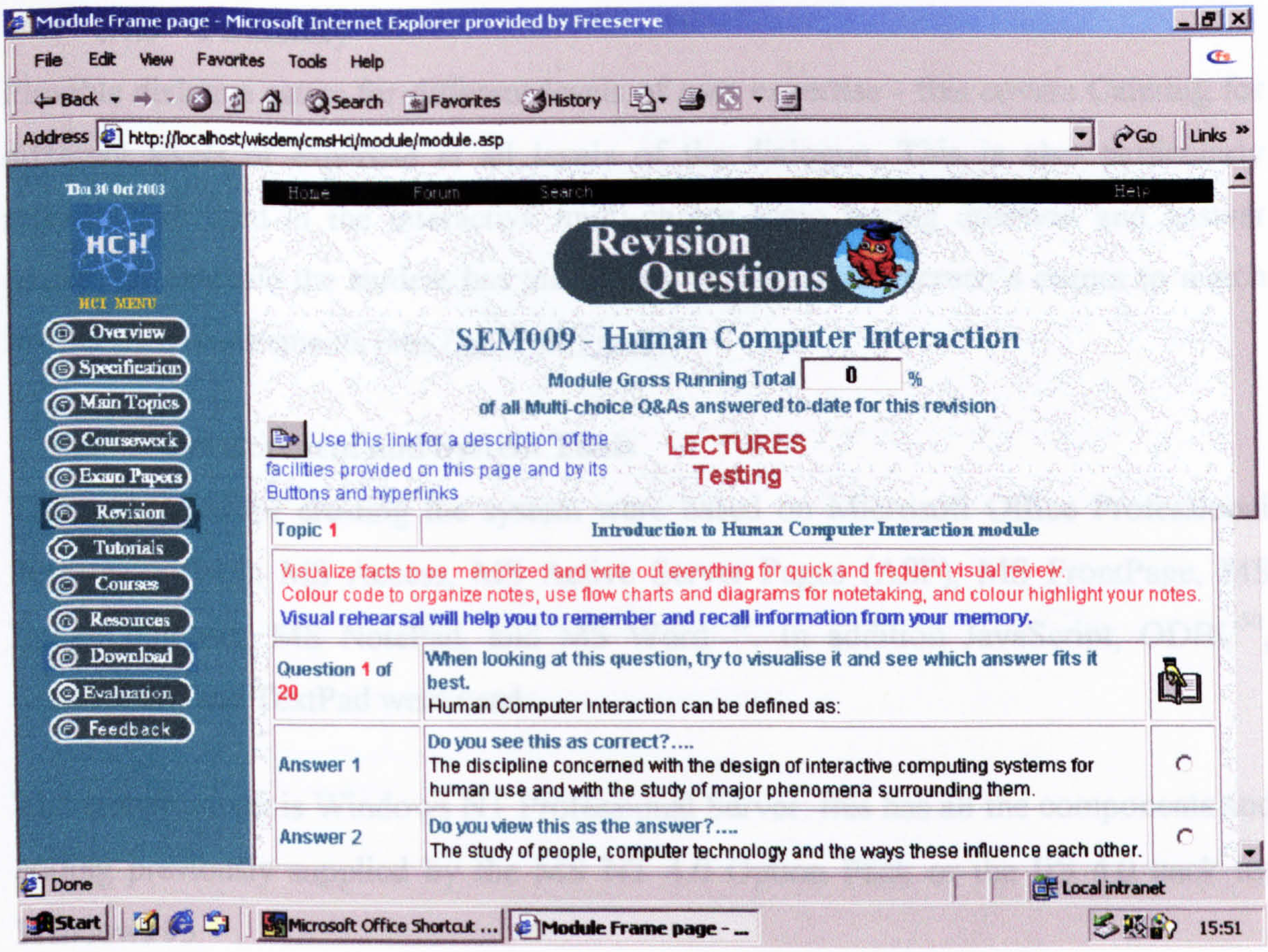


Figure 58 - Revision Topic Testing Pt 1

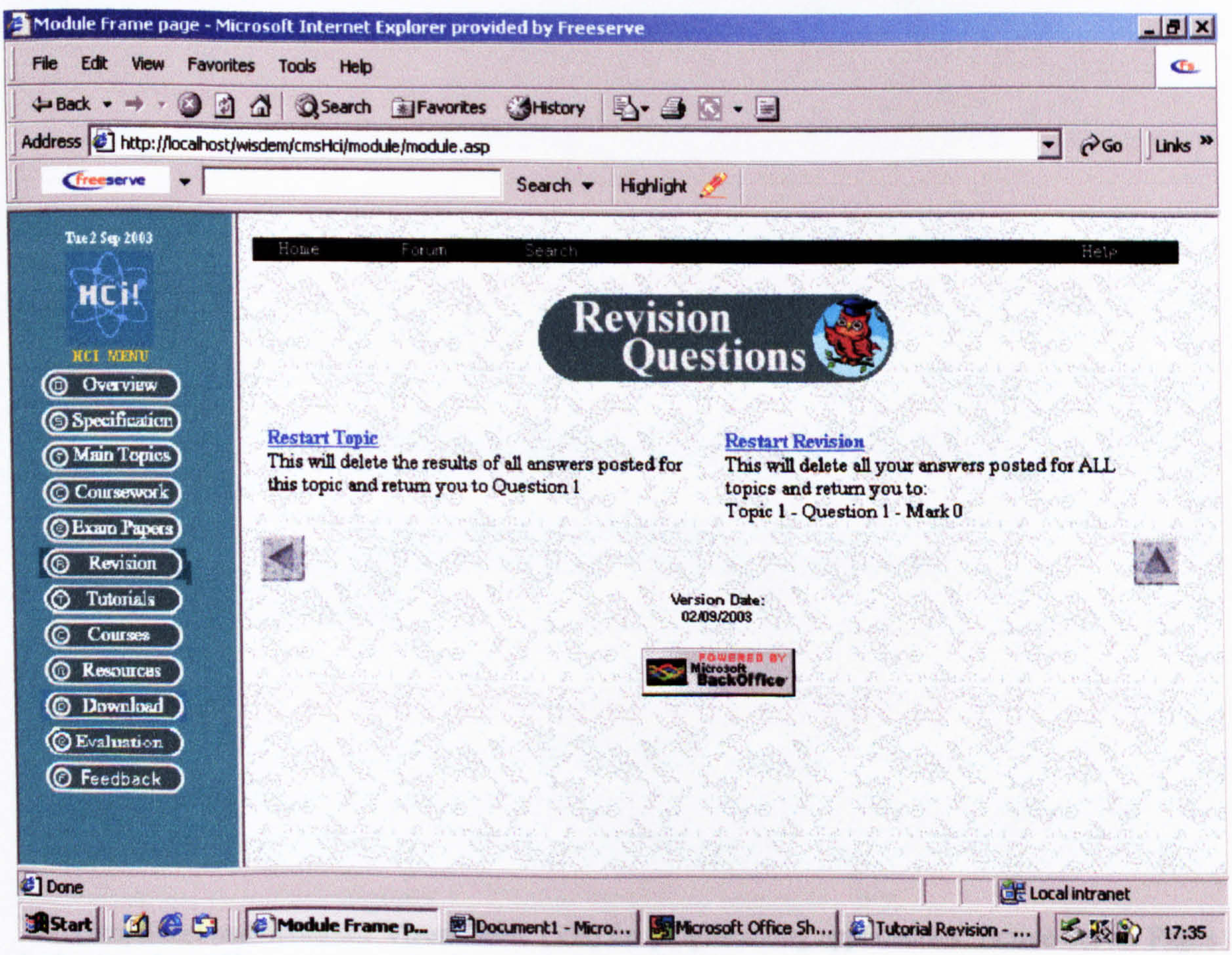


Figure 59 - Revision Restart Topic or Revision facility.

6.4.5 Flexibility

Flexible dialogue caters for different levels of user expertise - this covers Catering for different levels of expertise at all levels of the dialogue. This is also particularly relevant and used in the interactive multi-choice topic testing question and answer pages: for example the student has the facility to change the screen's output to match his/her own requirements (see Fig.60 & Fig.61).

6.5 Development and System Tools

The tools used for creating the system were based on Microsoft Office Professional 2000 suite (MS): MS Access, MS Active Server Pages (ASP), MS FrontPage, MS ImageComposer, MS NotePad, and MS Word [49]. In addition JavaScript, ODBC[50], SmartDraw, and TextPad were used.

The system server is Windows NT Professional Server: this has all the components and coding previously supplied by the MS NT 4.0 Option Pack or the IIS 4.0 pack for Windows 95.

[49] Access, Excel and Word use Visual Basic (VB) for programming applications: Active Server Pages is also based on VB.

[50] **ODBC** - Open Database Connectivity is an open standard application-programming interface (API) for accessing a database.

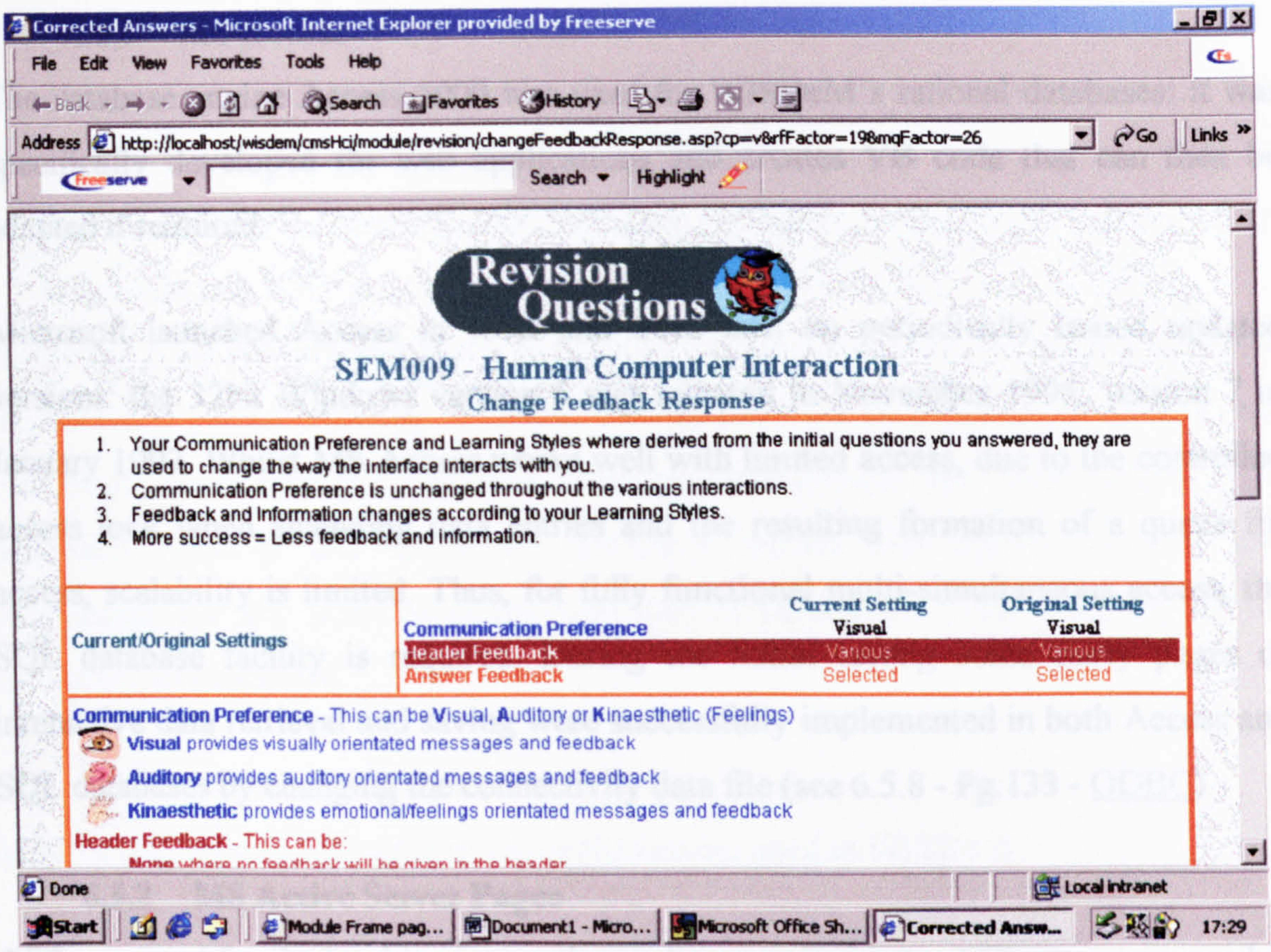


Figure 60 - Change Feedback response - Pt1.

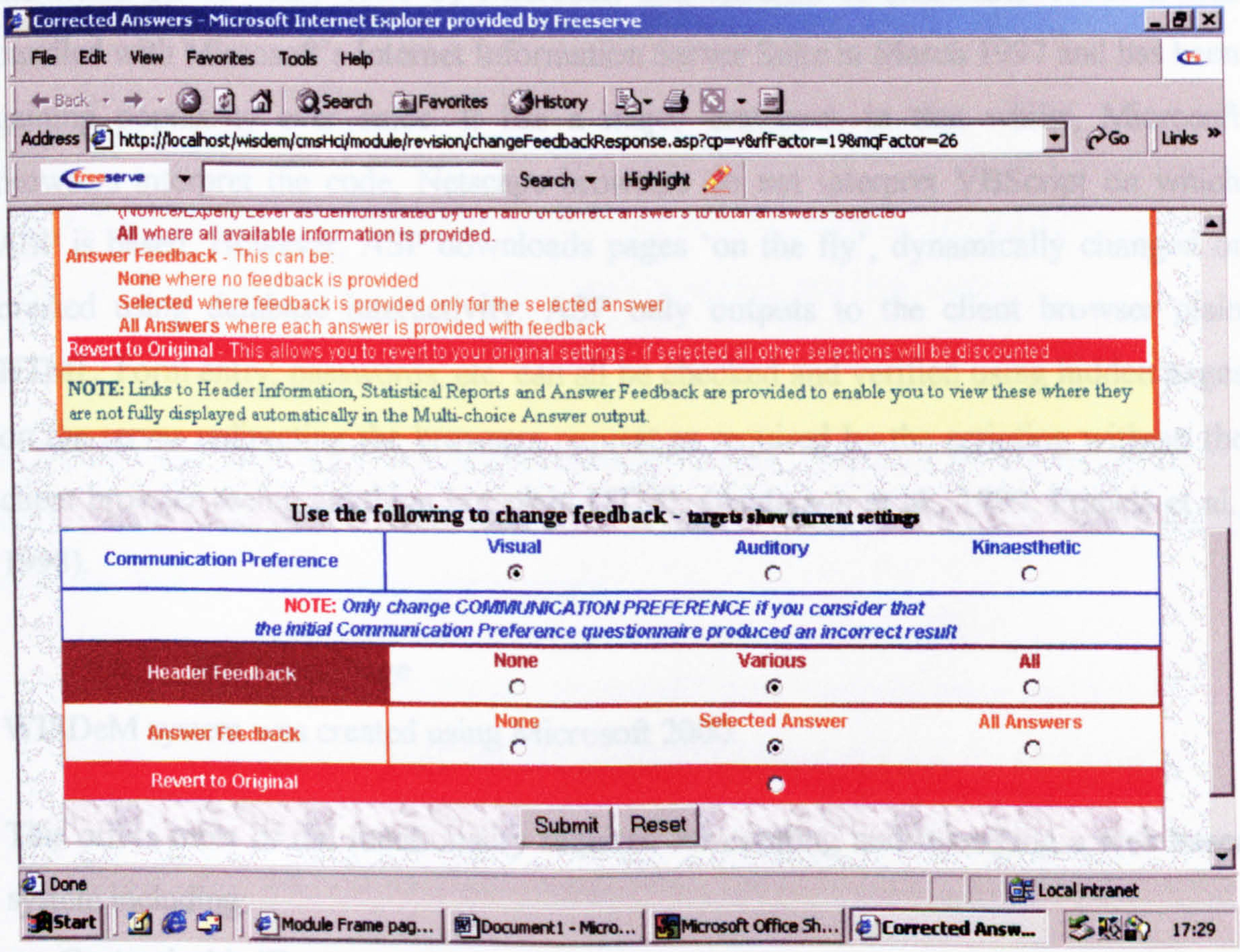


Figure 61 - Change Feedback response - Pt2.

6.5.1 MS Access

The database engine Access 2000 was used for WISDeM's rational databases: it was specifically developed for web applications and creates VB code that can then be adapted if required.

Microsoft launched Access in 1992 and from then on periodically issued updated versions: the 32bit Windows version 5 was released in November 1995, version 7 in January 1997. Whilst MS Access works well with limited access, due to the controlled access lock when amending data entries and the resulting formation of a queue for access, scalability is limited. Thus, for fully functional multi-simultaneous access, the SQL database facility is required. During the initial testing some thirty pages of interactive data retrieval and saving were successfully implemented in both Access and SQL databases by changing the connectivity data file (see 6.5.8 - Pg.133 - ODBC).

6.5.2 MS Active Server Pages

ASP was used for the intuitive interactive coding requirements. ASP was announced to the world on 16th July 1996 by Microsoft and released in December 1996. It was bundled with Microsoft's Internet Information Server Suite in March 1997 and has been gaining popularity ever since. It has a major drawback in that whilst, Microsoft browsers interpret the code, Netscape browsers do not interpret VBScript on which ASP is based. However, ASP downloads pages 'on the fly', dynamically changed or created using database interactivity: ASP only outputs to the client browser plain HTML. Form entry, passwords, etc. can all be checked and verified using hidden pages on the server redirecting the browsers request as required by the scripting without the client browser seeing anything but plain HTML (Anderson et al., 1999; Francis et al., 1998).

6.5.3 MS FrontPage

WISDeM system was created using Microsoft 2000.

This offers most of the functionality required for creating and managing a web based system including:

- Customizable Themes
- WYSIWIG screens (What-You-See-Is-What-You-Get)
- Rename pages and their links throughout the site

- Quick diagnosis and fix of problems
- Easy to cut and paste Access, Excel, Outlook, PowerPoint and Word
- Task manager, Hyperlink manager and Navigation manager
- In particular, when working in HTML code the highlighting of code insertion (viz. JavaScript and ASP) at a specific required point in the code.

FrontPage 2000 provides the additional facility of numbering (line and character) where the cursor is placed allowing for rapid code amendment as required. In addition the FrontPage 2000 version's facilities (manage workgroups and team efforts with document check-in and check-out, workflow reports and flexible security and permissions for any portions of the web site) is particularly useful working in the University environment.

6.5.4 MS ImageComposer

MS ImageComposer was used to create the images used in WISDeM.

Coupled with FrontPage is the Microsoft Image Composer, which allows for a wide range of different image types to be used, converted, created and animated.

6.5.5 MS NotePad & TextPad

Both MS NotePad and TextPad were used from time to time where text coding was required for reusable text code files such as the include libraries (see Fig.62). These are both ASCII text writers, the latter offers word-wrapping and line counting.

6.5.6 MS Word

MS Word was used for Tutor created module content. The files are written using the normal word processor and then saved as a HTML file. Each type of information has its own per-designated file name. For example:

..\..\wisdemTutor\cmshci\mod05\tutorial\tutorial01.htm = tutorial paper for topic 1

..\..\wisdemTutor\cmshci\mod05\lecture\presentation\lecture01.pdf = lecture slides

..\..\wisdemTutor\cmshci\mod05\lecture\notes\notes01.htm = notes

..\..\wisdemTutor\cmshci\mod05\information\information01.htm = specific information

..\..\wisdemTutor\cmshci\mod05\information\adInfRes01.htm = additional information

NOTE: PowerPoint created the PDF file.

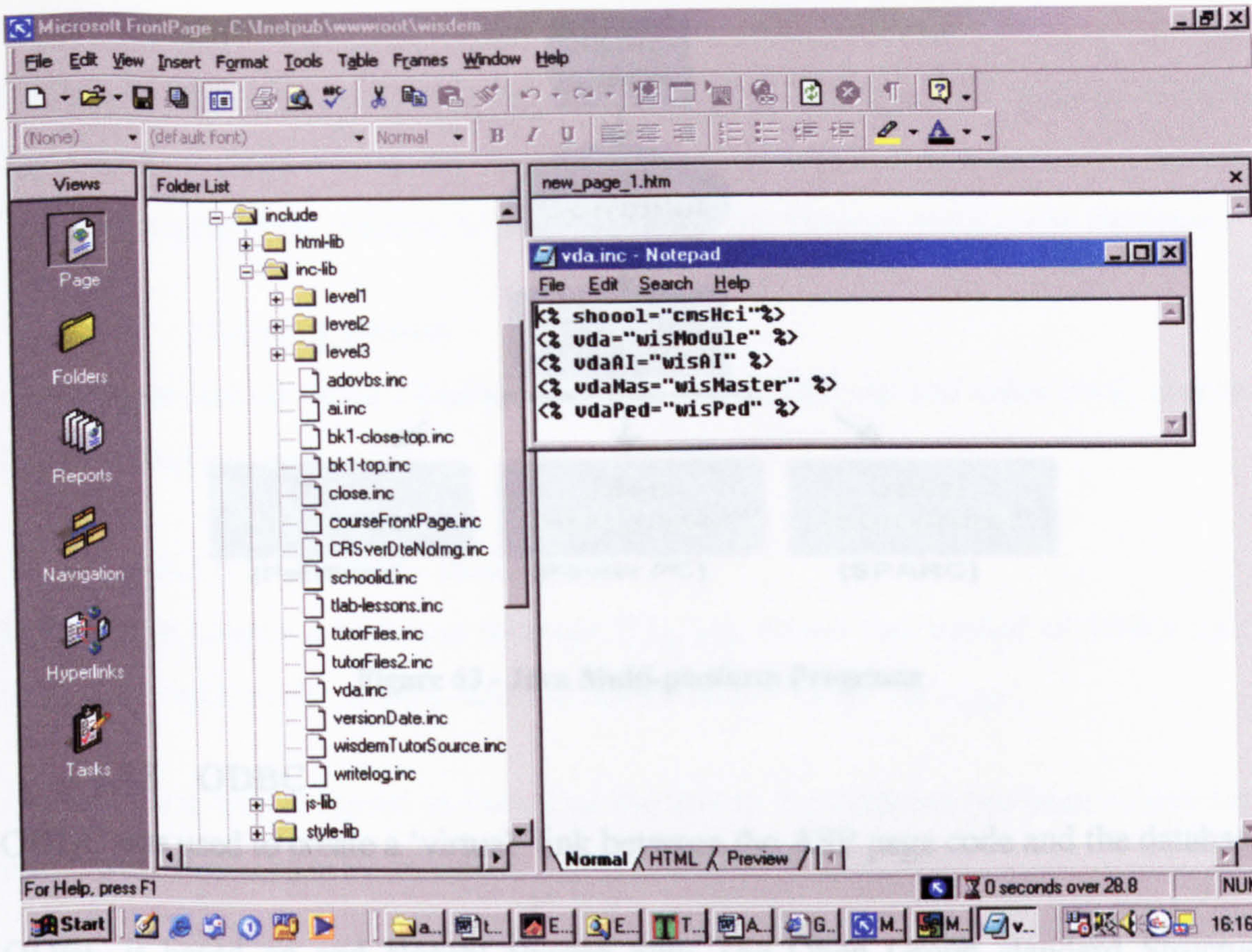


Figure 62 - Include Libraries - reusable text code files

6.5.7 JavaScript

JavaScript was used in WISDeM where output was required as the web page loaded. Much of the JavaScript coding is held in the JS library[51]. JavaScript is relatively easy to use and it has the advantage that both Netscape and IE engines interpret it. The download time is substantially quicker than Java; however, whilst being browser independent, it relies on a Java interpreter to output the result (see Fig.63).

Code is interpreted in the following order: ASP first by the server, then compiled executable code by the server, then JavaScript by the client, then VBScript (IE only) by the client, then Java code by the client, and finally HTML by the client browsers.

[51] **Libraries:** There are four types of libraries for reusable code: html-lib that holds html files, inc-lib hold ASP files, js-lib hold JavaScript files and style-lib holds style files. Each file is called appropriately as required by an 'incluce' statement.

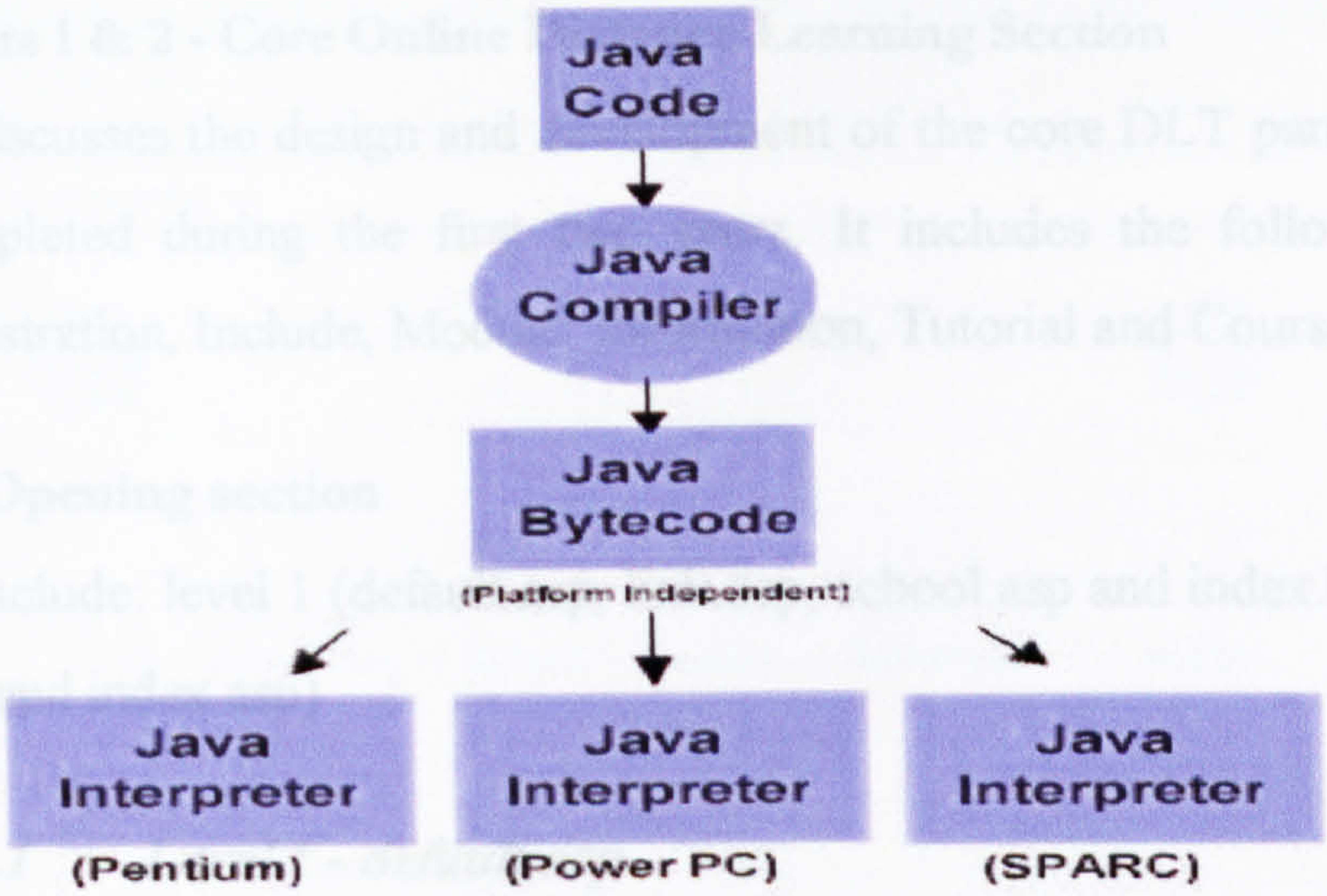


Figure 63 - Java Multi-platform Programs

6.5.8 ODBC

ODBC was used to create a 'virtual' link between the ASP page code and the database.

ODBC is based on and closely aligned with The Open Group standard Structured Query Language (SQL) Call-Level Interface. It allows programs to use SQL requests that access databases using virtual addresses without knowing the real address to the databases (viz. Access, SQL, Oracle). It processes the SQL request and converts it into a request that the individual database system understands. ODBC was created by the SQL Access Group and first released in September 1992 (Anderson et al., 1999).

6.5.9 SmartDraw

SmartDraw was used for many of the diagrams in WISDeM.

It is easy-to-use software for creating business charts and diagrams including Flowcharts - Time Lines - Organizational Charts - Software Design - Networks Forms - Floor Plans. It offers: easy "drag-and-drop" drawing - over 50,000 built-in symbols and clip art images - automatic alignment for neat, crisp drawings - built-in templates and examples - facility to import symbols and clipart - saves drawings for the web as GIF, JPG, or HTML - easily converts drawings made in other software, and is compliant with Microsoft Office.

6.6 Years 1 & 2 - Core Online Distance Learning Section

This section discusses the design and development of the core DLT parts of WISDeM that was completed during the first two years. It includes the following sections: Opening, Registration, Include, Module, Information, Tutorial and Course Revision.

6.6.1 Opening section

These pages include: level 1 (default.asp, link.asp, school.asp and index.htm), and level 2 (home4.asp and index.asp)

6.6.1.1 Level 1 - default.asp

Default.asp outputs a welcome message (Fig.64), shows the number of visitor entries to the site, displays the current date and automatically loads '*link.asp*'.

Default.asp is also designed to show that the link to the database has been established[52] and uses reusable code by linking to the relevant library files:

```
<!-- #include file="wisdemInclude/adovbs.inc" //-->
<!-- #include file="wisdemInclude/vda.inc" //-->
<script language="javaScript"></script>
<script src="wisdemInclude/dhtmlapi.js"></script>
<script src="wisdemInclude/ddmmyyyy.js"></script>
```

---

[52] **Default.asp check to see database is actively connected**

```
<%
' output error number if no connection to database
IF visitNo=zeroLen THEN 'check data read error
	response.write("000001")	'if error output a count
ELSE
	response.write(newCount)	'if no error output new number
END IF
%>
```

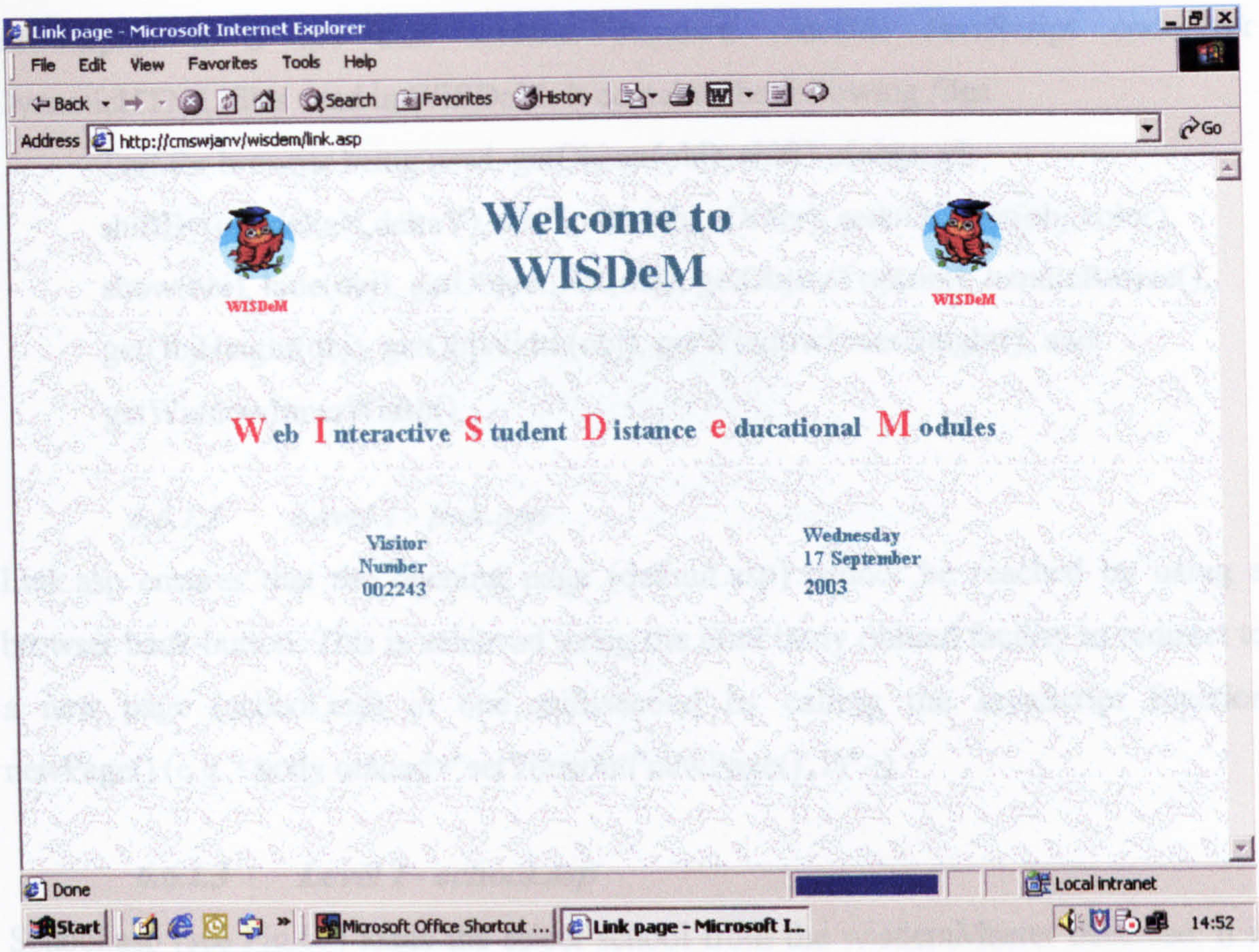


Figure 64 - WISDeM opening screen

adovbs.inc was issued by Microsoft in 1996 to cover all the ADO constants include file for VBScript. This file is required to provide the constant variable data required to open, amend, save and delete database files using ASP in WISDeM.

vda.inc is the standard database virtual address WISDeM file. Changing the value of a variable enables the database source to be changed. Thus changing "*wisModule*" to "*sqlWisModule*" would have the effect of changing the database from an Access database source to an SQL database source with a virtual address name of "*sqlWisModule*". This one change affects all pages that use the former virtual address.

In this *Default.asp* page, as in all other database linking pages the following code opens database connectivity, in this instance using the virtual address 'vdaMas'.

```
                                   'open ODBC connection
Set objCon=Server.CreateObject("ADODB.Connection")
                                   'link to virtual address
objCon.Open ""&vdaMas&""
```

dhtlmapi.js is a file that contains standard reusable JavaScript code for DynamicHTML files used in WISDeM. It contains the following files:

Test for browser being used, getObject(obj), shiftTo(obj,x,y), shiftBy(obj,deltaX,deltaY), setZIndex(obj,zOrder), setBGColor(obj,color), show(obj), hide(obj), getObjectLeft(obj), getObjectTop(obj), handleResize(), getObjHeight(obj), getObjWidth(obj), getWindowInnerHeight(), and getWindowInnerWidth().

6.6.1.2 Level 1 - link.asp

Link.asp ensures that the opening page (default.asp) cannot be reached by using a browser back-button. This is achieved using the html body onload facility to redirect to a new page (school.asp) in one millisecond by calling the JavaScript function newPage() (e.g. <body onload="setTimeout('newPage()',1)">).

6.6.1.3 Level 1 - school.asp

School.asp (see Fig.65) loads the select school from the wisdemMaster database. It is designed for scalability to allow the system to be used across the university. The page links to the selected school's server at the initial file 'index.asp'. In this development stage of WISDeM the only school link is cmsHci - School of Computing and Mathematical Sciences - Human Computer Interaction modules.

6.6.1.4 Level 2 - index.asp

Index.asp is the main module link page. It controls session variables by automatically cancelling out all variables as the user is directed through the page. This allows the module server to reset a user's access authority and normally calls the school's front page, home4.asp, within a millisecond, if not an error message appears whilst the front page is being loaded.

6.6.1.5 Level 2 - home4.asp

Home4.asp is made up of a series of tables that are filled by data (text, images) as controlled by the database table 'frontpage' (see Fig.66 & Fig.67).

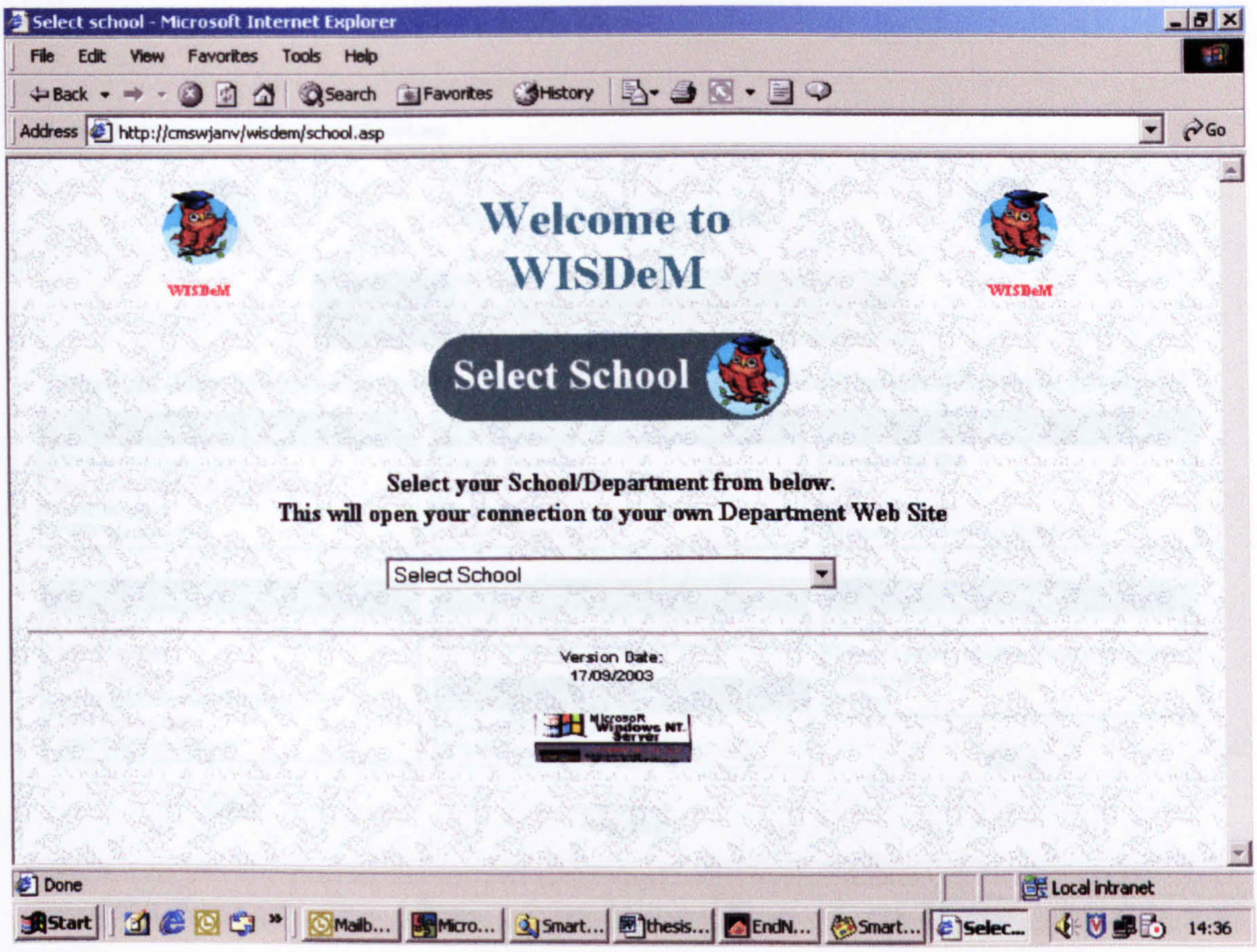


Figure 65 - WISDeM school selection

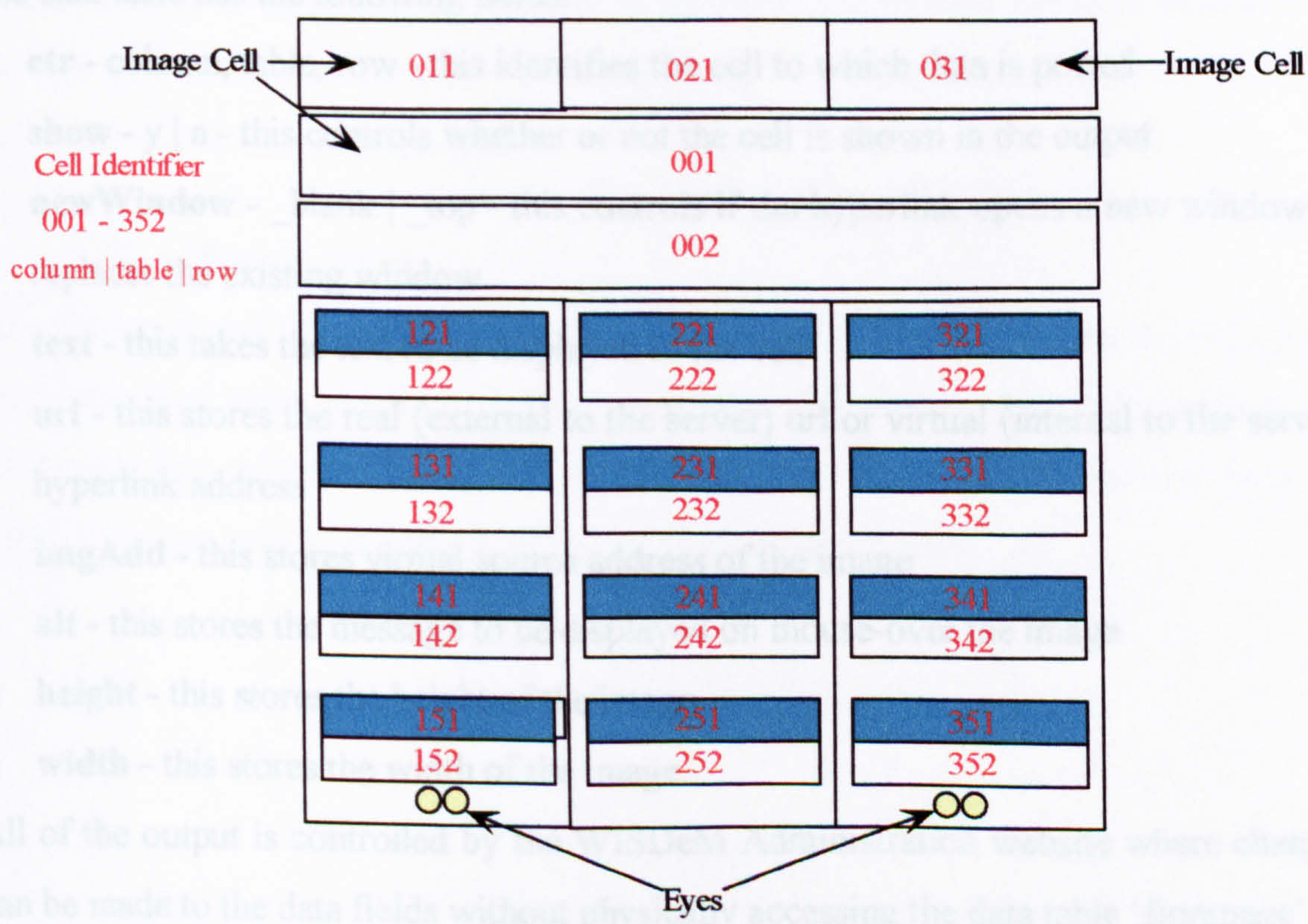


Figure 66 - FrontPage table design - filled by database calls

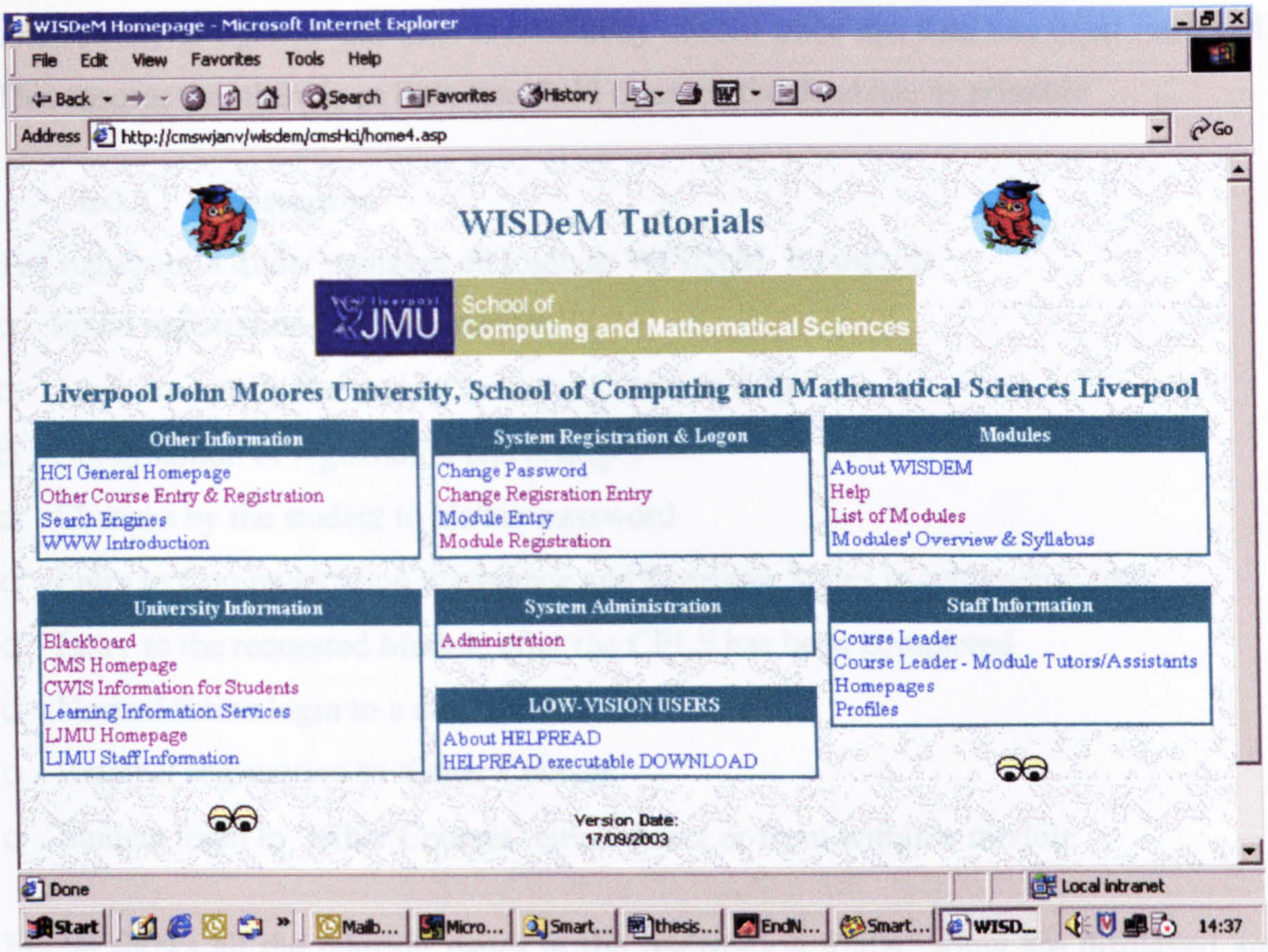


Figure 67 - WISDeM Tutorial front page

The data table has the following fields:

- **ctr** - column, table, row - this identifies the cell to which data is posted
- **show** - y | n - this controls whether or not the cell is shown in the output
- **newWindow** - _blank | _top - this controls if the hyperlink opens a new window or replaces the existing window
- **text** - this takes the text to be displayed in the cell
- **url** - this stores the real (external to the server) url or virtual (internal to the server) hyperlink address
- **imgAdd** - this stores virtual source address of the image
- **alt** - this stores the message to be displayed on mouse-over the image
- **height** - this stores the height of the image
- **width** - this stores the width of the image.

All of the output is controlled by the WISDeM Administration website where changes can be made to the data fields without physically accessing the data table 'frontpage'.

The page checks to see if a particular table is open, stores this information and then calls for data for each cell in all the open tables. As each call is made the data connectivity is opened and then immediately closed once the data has been retrieved. This ensures that there is as little time held open on the database as possible.

6.6.2 Registration

The registration folder manages all login to WISDeM. It controls:

- Initial registration from the student
- Amendments by the student to this registration detail
- Confirmation of registration and changes
- Changes by the student to his/her password
- Entry to Communication Preference and Learning Styles psychometric tests
- Entry to the requested Module after the CPLS has been completed
- Normal future login to a module
- External registration to 'Other Courses'
- Student login to 'Other Courses' either direct or from within a module.

Fig.68 shows all the relevant pages in the registration folder: some are displayed and some are hidden. As a student logs in session variables are set up which ensure that student usage of the website can be monitored and saved as relevant to the databases to enable future tracing, linking and control as required. The session variables have a time-to-close span of ten minutes after which time none use of the system clears the variables and forces the student to log in again.

6.6.3 Module folder

This section covers the module folder (see Fig.69 & Fig.70) that contains the links to all the pedagogical material held in the tutor-controlled files in the 'wisdemTutor' web, the interactive files held in 'wisdemCPLS' web, and the wisdemData files that hold the interactive data, which, is controlled by the wisdemAdmin web.

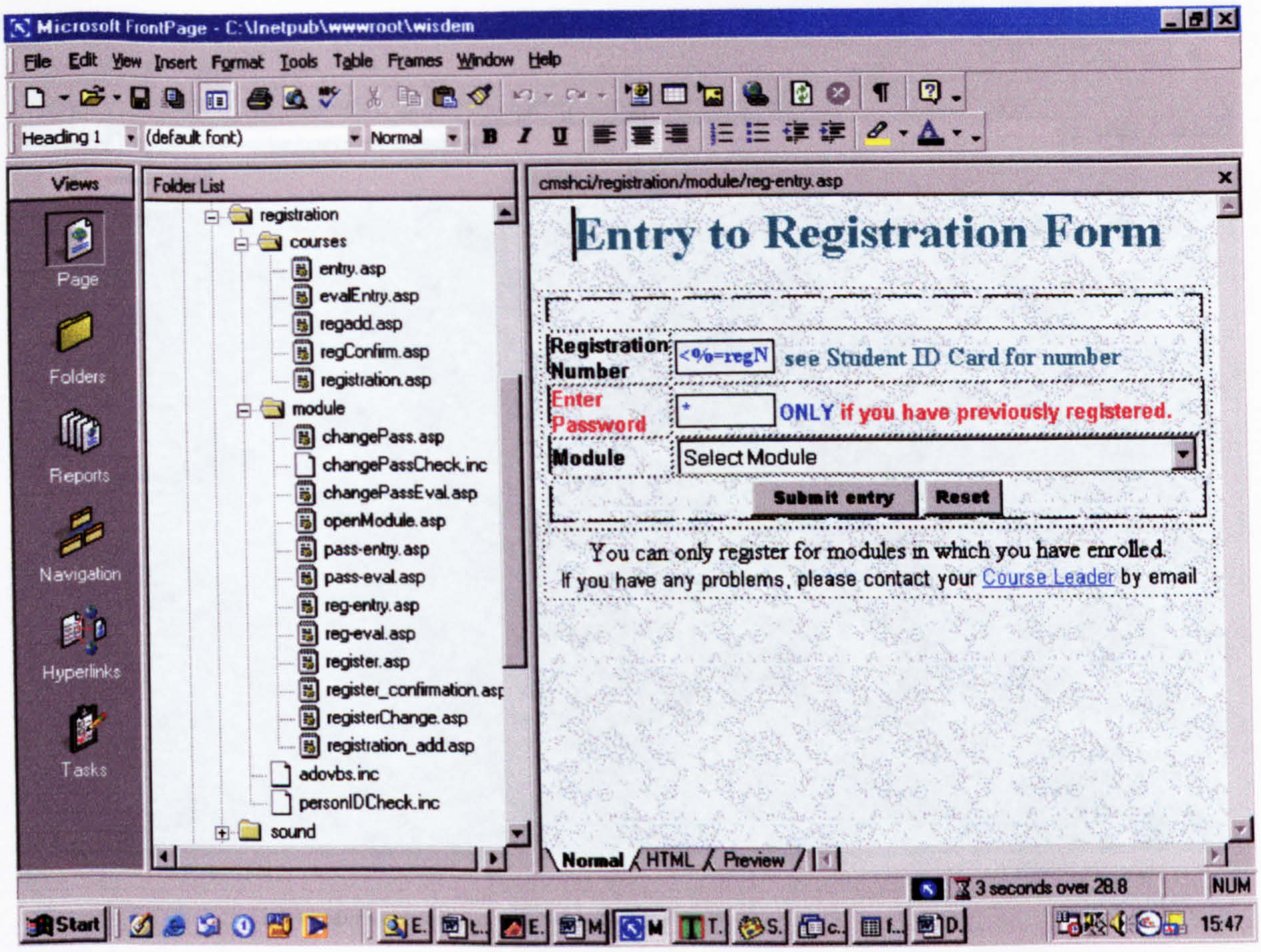


Figure 68 - The Registration folder

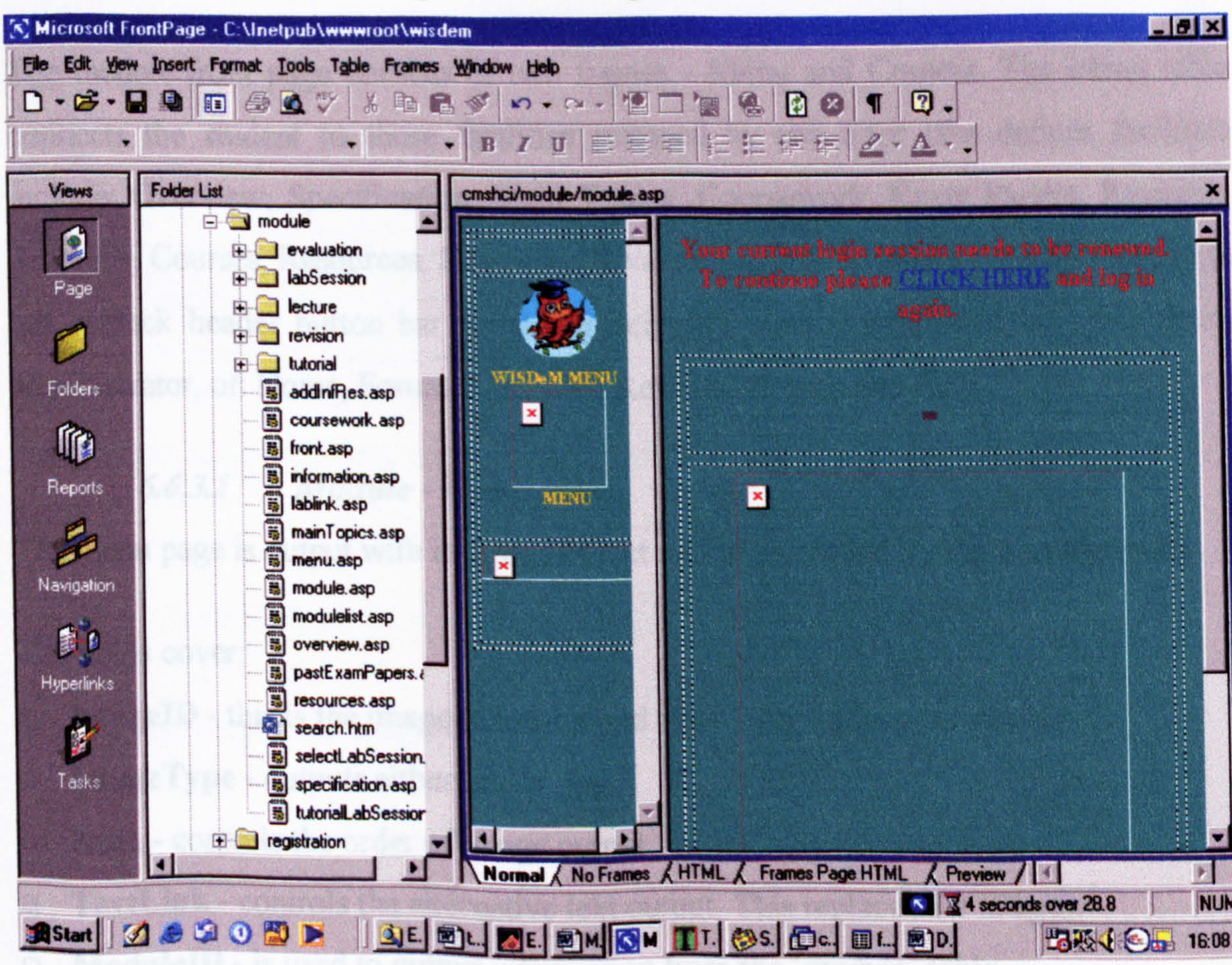


Figure 69 - Module folder - the main teaching facility

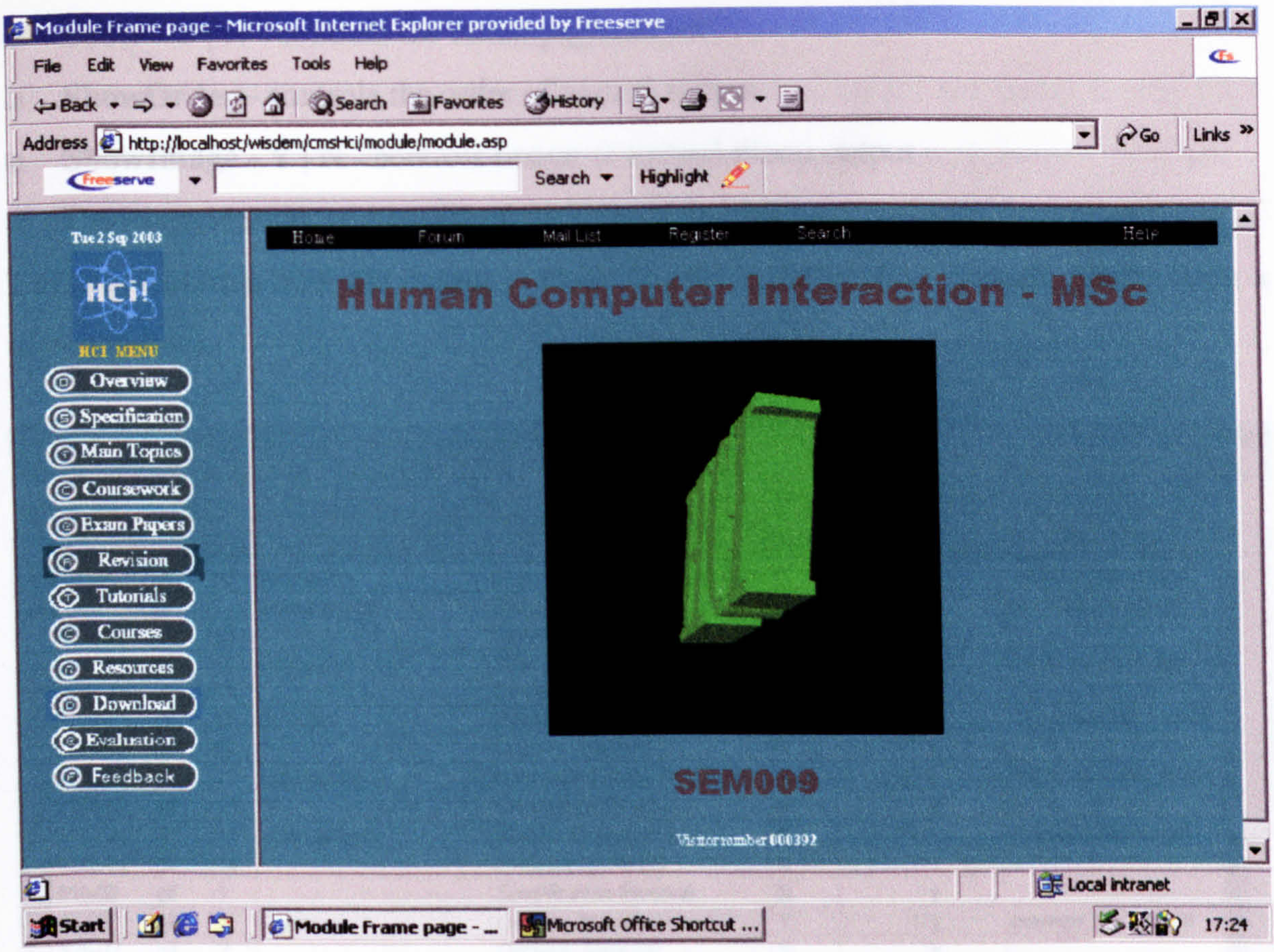


Figure 70 - WISDeM Module front link page

The module front page consists of two frames - Menu and Content. The Menu table connects the student to those facilities released by the tutor (the default facilities include: Overview, Specification, Main Topics, Coursework, Exam Papers, Revision, Tutorials, Courses, Resources, Download, Evaluation, and Feedback), the Content page has a black header button bar providing default facilities, controlled by the website administrator, of: Home, Forum, Mail List, Register, Search and Help.

6.6.3.1 Module - Menu frame

The menu page is output with images OR text and is controlled by the data file menu.

The fields cover:

- **ImageID** - this is the image identifier and allows for mouseover display
- **ImageType** - outputs either .gif or .jpg
- **Num** - controls the order of image output
- **TextLink** - controls the alternative text output. This replaces the images.
- **ModuleID** - is used to output information from the 'module' table
- **Alt** - provides the text display messages on mouseover image

- **Show** - Y | N - controls the initial page output
- **ShowOrder** - controls the order of textual output
- **ShowImage** - Y | N - controls image or textual menu output
- **Url** - provides the real or virtual address of the link

Target - controls how the output is made (right=in the content frame, _blank=open a new window).

Microsoft Access - [menu : Table]

imageID	imag	num	textLink	moduleID	alt	show	showOr	showIm	url	target
[illegible]	gif	10	Tutorial-Qs		Short Questions on each Tuto	Y	8	y	../module/tutori	right
ft1-02	gif	1	Specification		Specification - Details of Cour	Y	2	y	specification.as	right
ft10b-02	gif	10			Tutorials (reverse)	N		y		
ft11-02	gif	11	Online-Qs		Short Online Tutorial Question	n	7	y	link to be writte	right
ft11b-02	gif	11			On-line Questions (reverse)	N		y		
ft12-02	gif	12	Courses		Link to Other Courses	Y	9	y	../courses/link.	_blank
ft12b-02	gif	12			Courses (reverse)	N		y		
ft13-02	gif	13	Netmeeting		Netmeeting dates for this mod	n	14	y	link to be writte	_blank
ft13b-02	gif	13			Netmeeting (reverse)	N		y		
ft14-02	gif	14	Module Evalu		Module Evaluation forms	Y	12	Y	evaluation/intro	right
ft14b-02	gif	14			Evaluation(reverse)	N		Y		
ft1b-02	gif	1			Specification (reverse)	N		y		
ft2-02	gif	2	Overview		Overview to course	Y	1	y	overview.asp	right
ft2b-02	gif	2			Overview (reverse)	N		y		
ft3-02	gif	3	Main Topics		Details of Lecture/Lab Sessio	Y	3	y	mainTopics.as	right
ft3b-02	gif	3			Main Topics (reverse)	N		y		
ft4-02	gif	4	Coursework		Full coursework specification	Y	4	y	coursework.as	right
ft4b-02	gif	4			Coursework (reverse)	N		y		
ft5-02	gif	5	Exam Papers		Past Exam Papers	Y	5	y	pastExamPape	right
ft5b-02	gif	5			Exam Papers (reverse)	N		y		
ft6-02	gif	6	Resources		Resources - Link to useful adc	Y	10	y	../information/re	_blank
ft6b-02	gif	6			Resources (reverse)	N		y		
ft7-02	gif	7	Feedback		Student feedback facility	Y	13	y	../feedback/mo	_blank
ft7b-02	gif	7			Feedback (reverse)	N		y		
ft8-02	gif	8	Download		Downloads - Link to useful fre	Y	11	y	../information/d	_blank

Record: 1 of 34

Datasheet View

Figure 71 - Menu data table controlling the Module front page output

Changes to the menu data table are controlled using the wisdemAdmin web by the tutor.

The menu facilities links have been implemented using the link file

```
<!--#include file="../include/inc-lib/tutorFiles.inc" //-->
```

This coding links to the wisdemTutor server using select case coding.

6.6.3.2 Module - Content frame

This frame has been implemented to take the data selected by the menu frame. Each page uses reusable code to load the black header menu bar calling an include text file:

- **Home** - this links with either the school front page or the module front page as relevant.
- **Forum** - opens a forum page that is specific to the current module. The forum link has been implemented to open a new window. The forum provides: *Search* (search for any string within the forum database for this module), *Post* (post a new thread), *Reply* (reply to an existing thread), and *Display* an entry. As normal with forums, each entry is linked chronologically to the source and indented as relevant. The database records also time of posting, studentID and password to enable all entries to be traceable (see Fig.72).
- **Mail List** - provides the facility for a student to request the tutor to be included in a mail-list (see Fig.73).
- **Register** - allows the student to make changes to his/her registration entry including changing the password.
- **Search** - allows the student to search for any text string entry within the module.
- **Help** - opens a help facility specific to the Module (see Pg.123 - Fig.53).

6.6.4 Information (pedagogical)

The default facilities provide the tutor with normal DLT input with the following information sections: Overview, Specification, Main Topics, Coursework, and Exam Papers. All tutor created information is held in the wisdemTutor server where each module has the same list of content files (see footnote - List of Tutor Module Files [53] and 5.7.1 - Pg.114 - General Folders). The totality of these files allows the tutor the wide scope to present pedagogical content both specific to a topic and general to the module in a wide variety of methods using MS Word text documents, Adobe PDF files, MS Excel spreadsheets, MS PowerPoint, and within these any external relevant links or programs.

[53] **List of wisdemTutor module files:** addInfRes - via Information, coursework, exam, information - via Main Topics, lecture (notes & presentation) - via Main Topics, overview and tutorial.

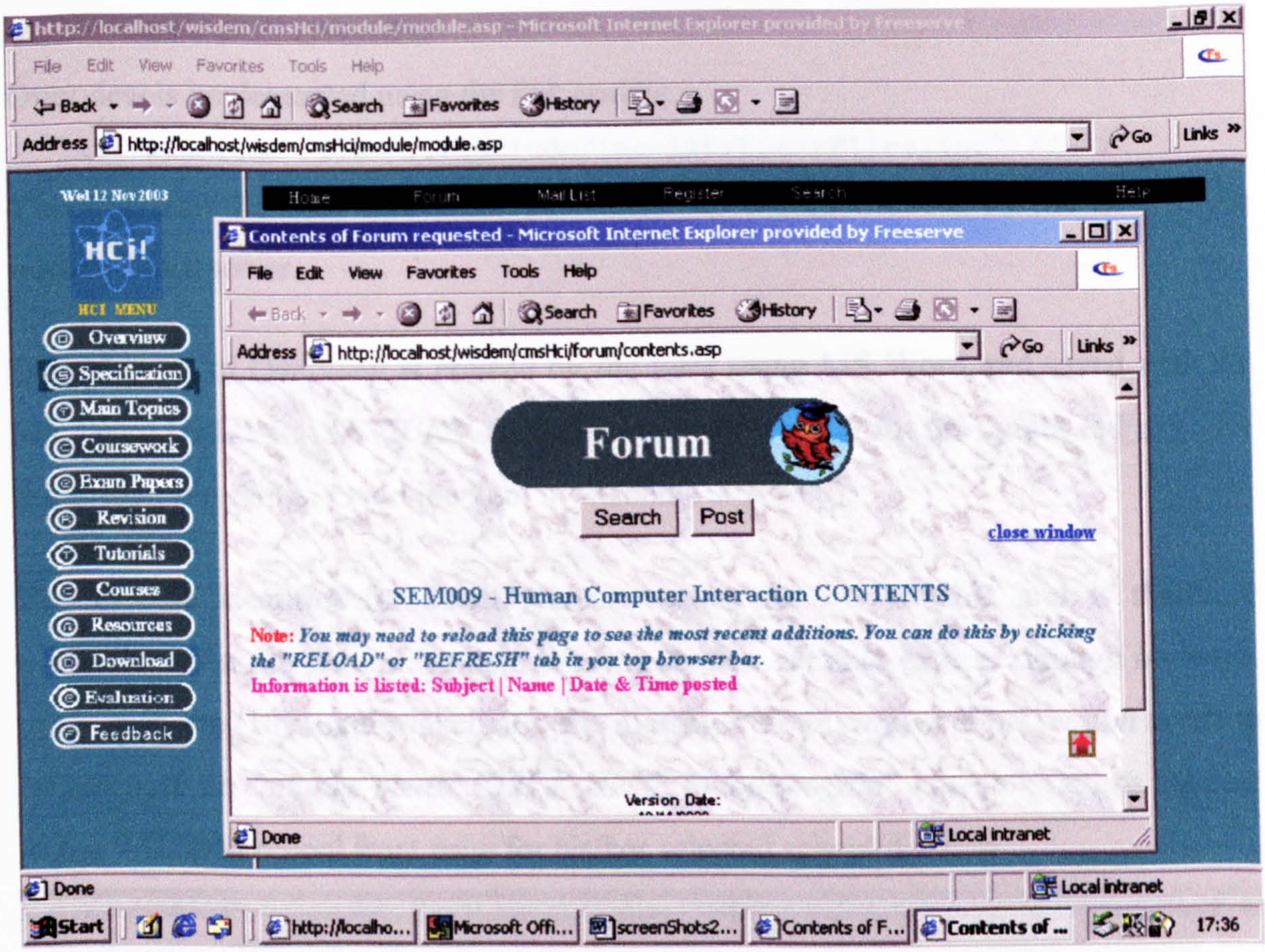


Figure 72 - Module Forum facility

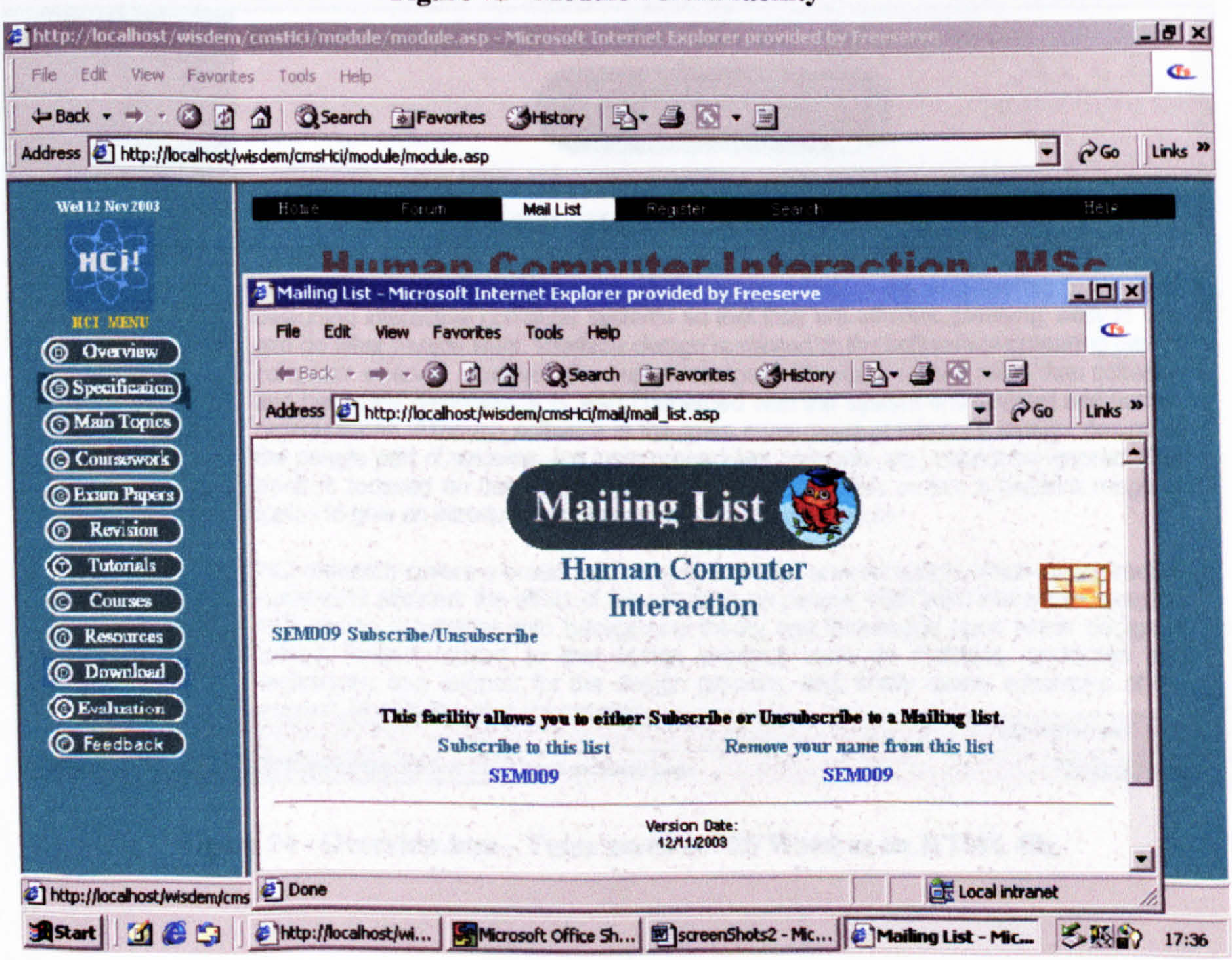


Figure 73 - Mail list facility

6.6.4.1 Overview

Overview is implemented using the link coding:

```
<!--#include file="../include/inc-lib/tutorFiles.inc" //-->
```

This link uses the code from tutorFiles.inc to call the data loaded by the tutor in the wisdemTutor server.

The contents of Overview is created by the tutor using MS Word and saved with the MS Word facility to 'SAVE AS' an HTML file (see Fig.74. for the output & Fig.75 for the system file calling Overview.htm in wisdemTutor web).

The module identifier (moduleID) is carried as session variable and is therefore available whilst the session is open. When a session variable expires through none-use of the web site (10 minutes inactivity) the message "*Your current login session needs to be renewed. To continue please CLICK HERE to login again*" - the link returns the user to the WISDeM school front page for his/her selected school/division.

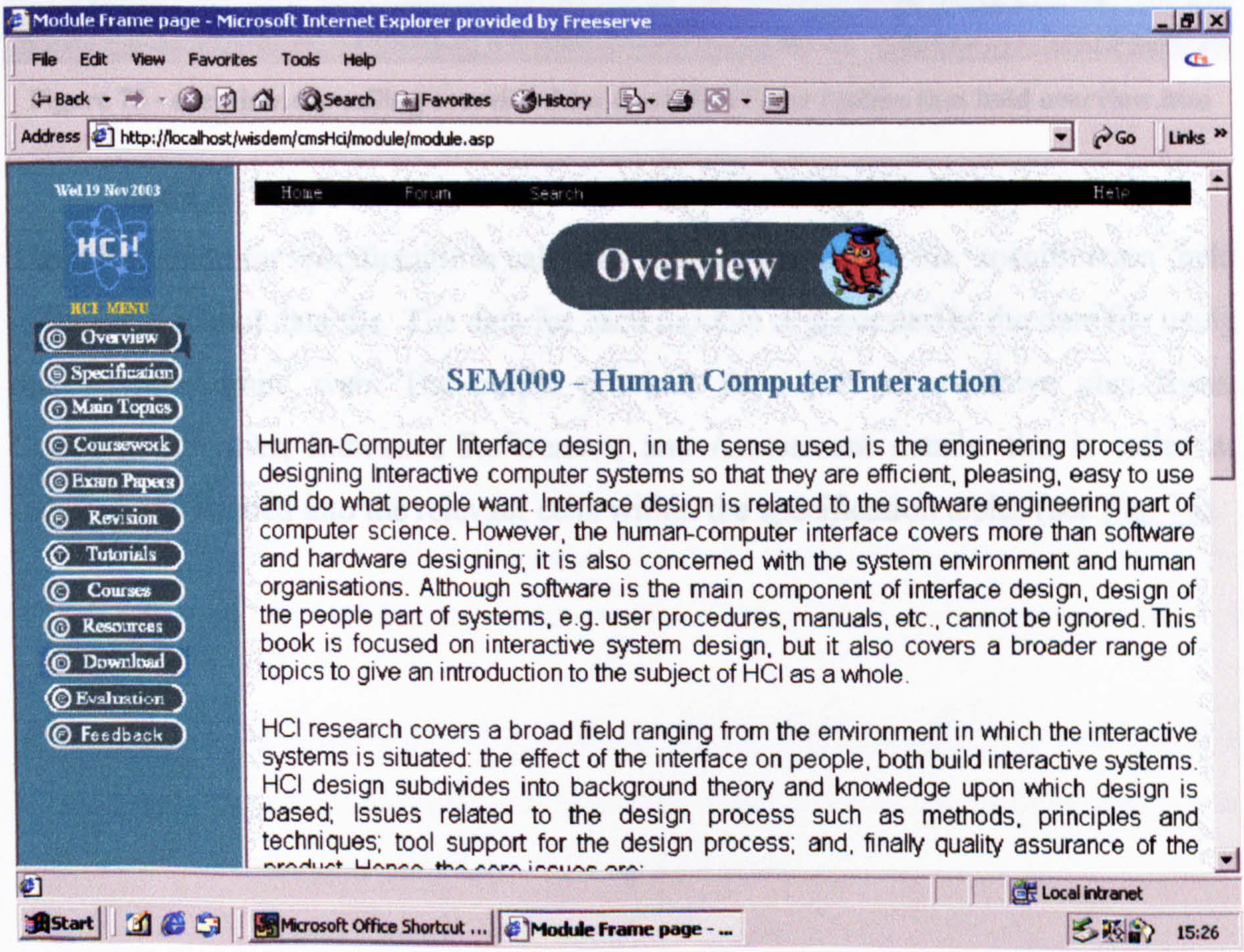


Figure 74 - Overview.htm - Tutor saved in MS Word as an HTML file.

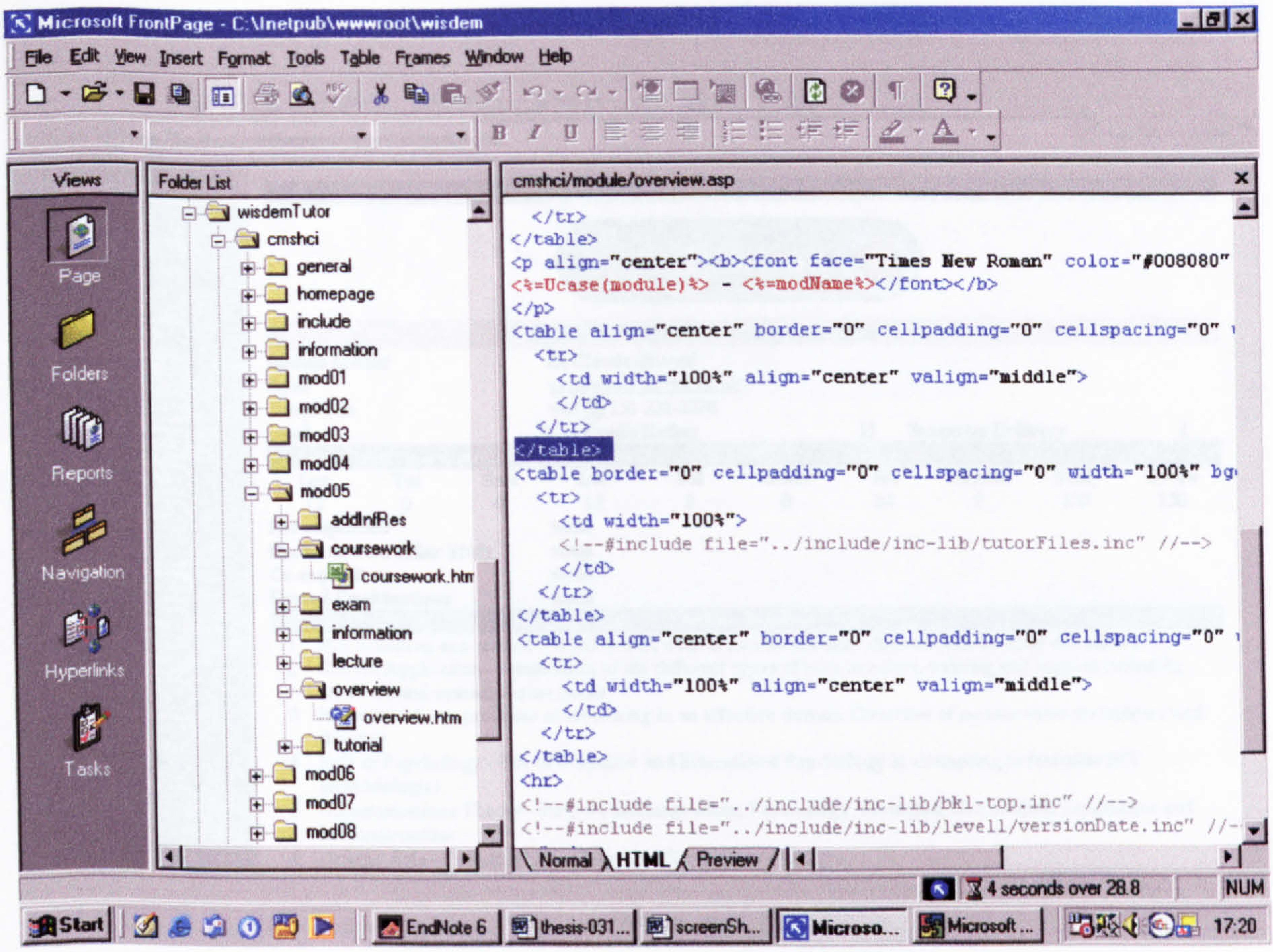


Figure 75 - overview.asp calling overview.htm & wisdemTutor folders that hold overview.htm

6.6.4.2 Specification

The information for specification is called directly from the data file 'specification' held in the main school data file. The data for each module is generated in the data file using the 'wisdemAdmin' web. The output provides the information shown plus Aims, Learning Activities, Indicative References, and Assessment details: this is called as required and entered into the relevant cells within the specification tables (see Fig. 76).

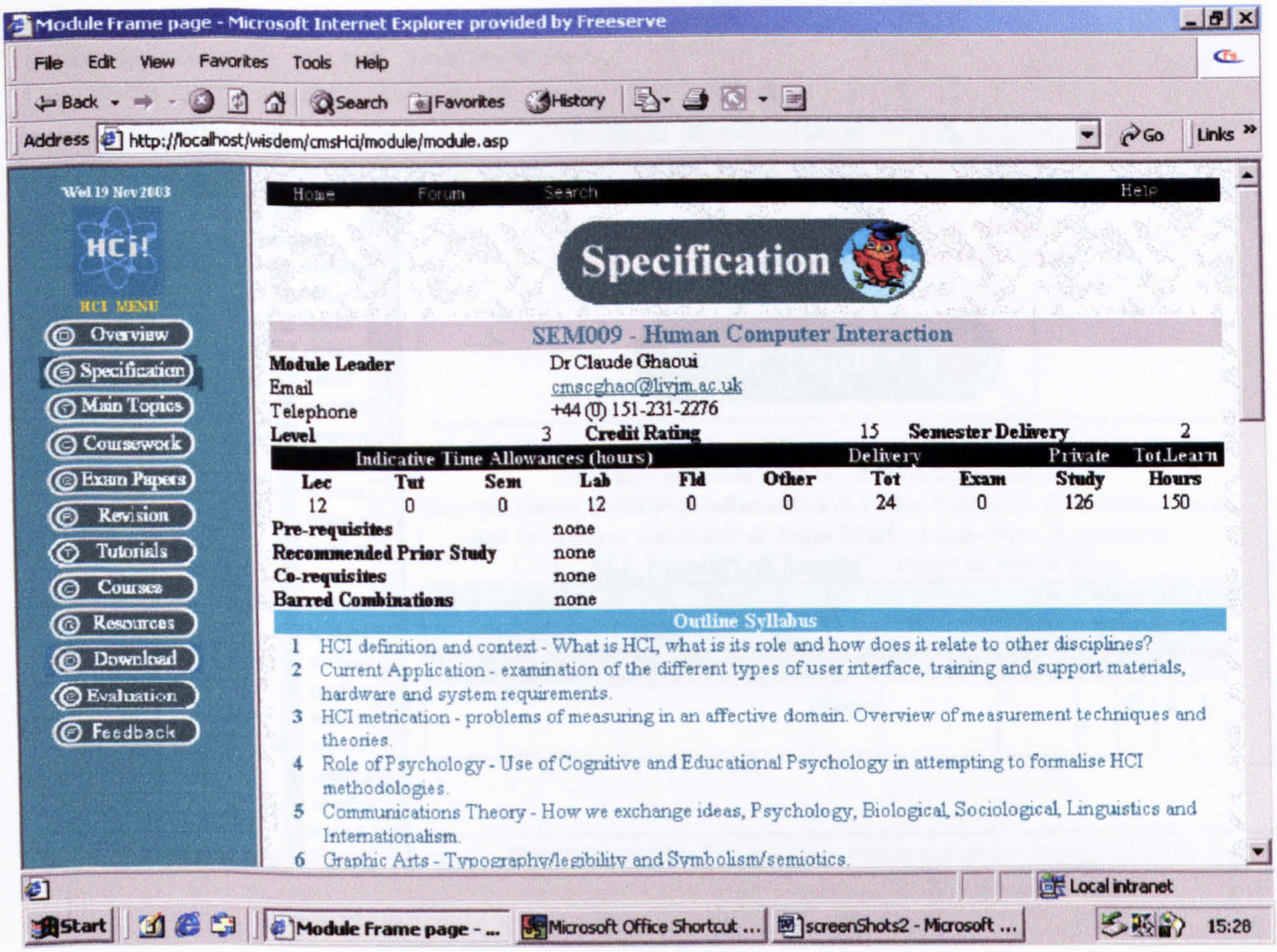


Figure 76 - Specification output

6.6.4.3 Main Topics

Main Topics provides the student with the important module pedagogical information. It is implemented using tables and links (see Fig.77 for construction & Pg.113 - Fig.49 for output).

The page provides the student with links to:

- **Notes** - specific for a particular topic. The tutor creates these as a word document saved as .HTM and can be found in the wisdemTutor web as a sub-folder of lecture.
- **File Type** - provides a link to the lecture slides (.ppt) or Adobe PDF file. The data file 'mainTopics' allows the tutor to specify either type via the wisdemAdmin web. The mainTopics page uses the following ASP code:

```
<a
href="<%=wisdemTutorSource%>/<%=schoolID%>/<%=moduleID%>/lecture/pres
entation/lecture<%=rsPage("topicNum")%>.<%=rsPage("presentationFileTy
pe")%>" target="_blank">
    <%=Ucase(rsPage("presentationFileType"))%></a>.
```

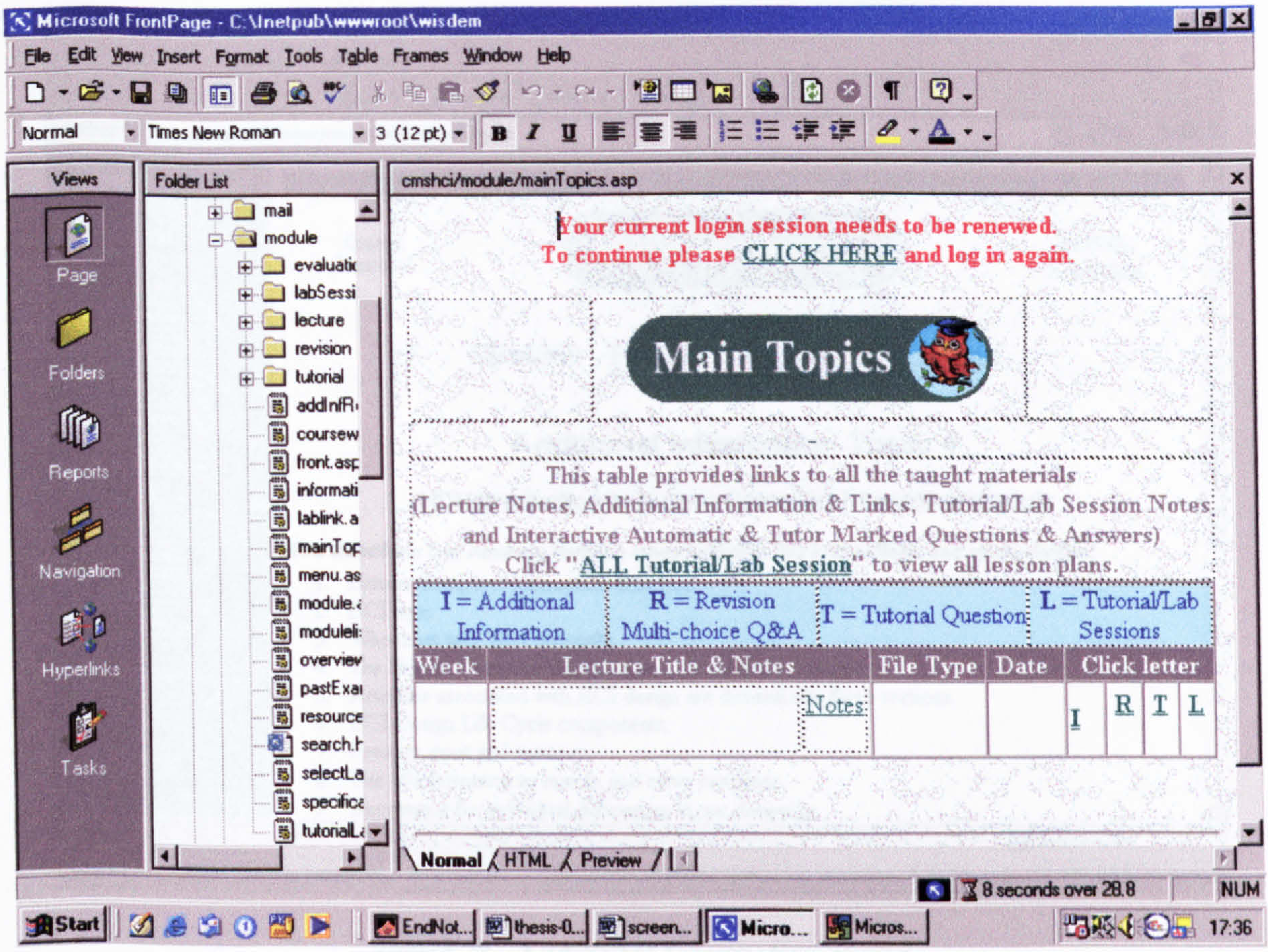


Figure 77 - mainTopics.asp - page construction

- **Additional Information** - provides the student with any additional information deemed relevant. The link is implemented to call for information from the wisdemTutor web posted by the tutor using MS word saved as HTM. The Additional Information page (see Fig.78) is constructed to load tutor-generated information from the database into the centre of the page. It also provides the student with links to General Resources (see Fig.79) and Specific Resources (see Fig.80).

It uses the following coding in the Main Topics page to affect the link to call the Information page:

```
<a href="information.asp?weekNum=<%=rsPage("topicNum")%>">I</a>
```

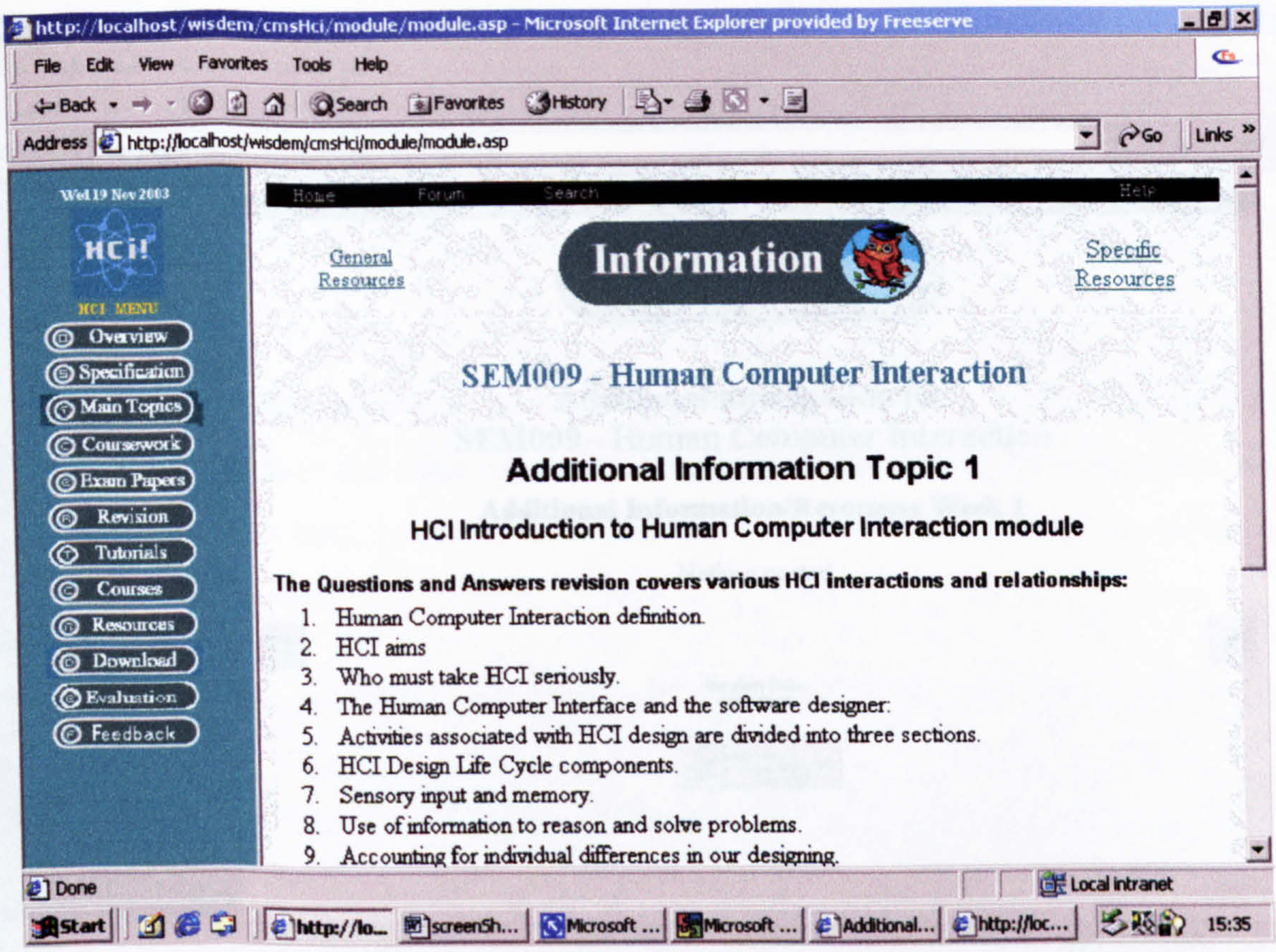


Figure 78 - Additional Information screen

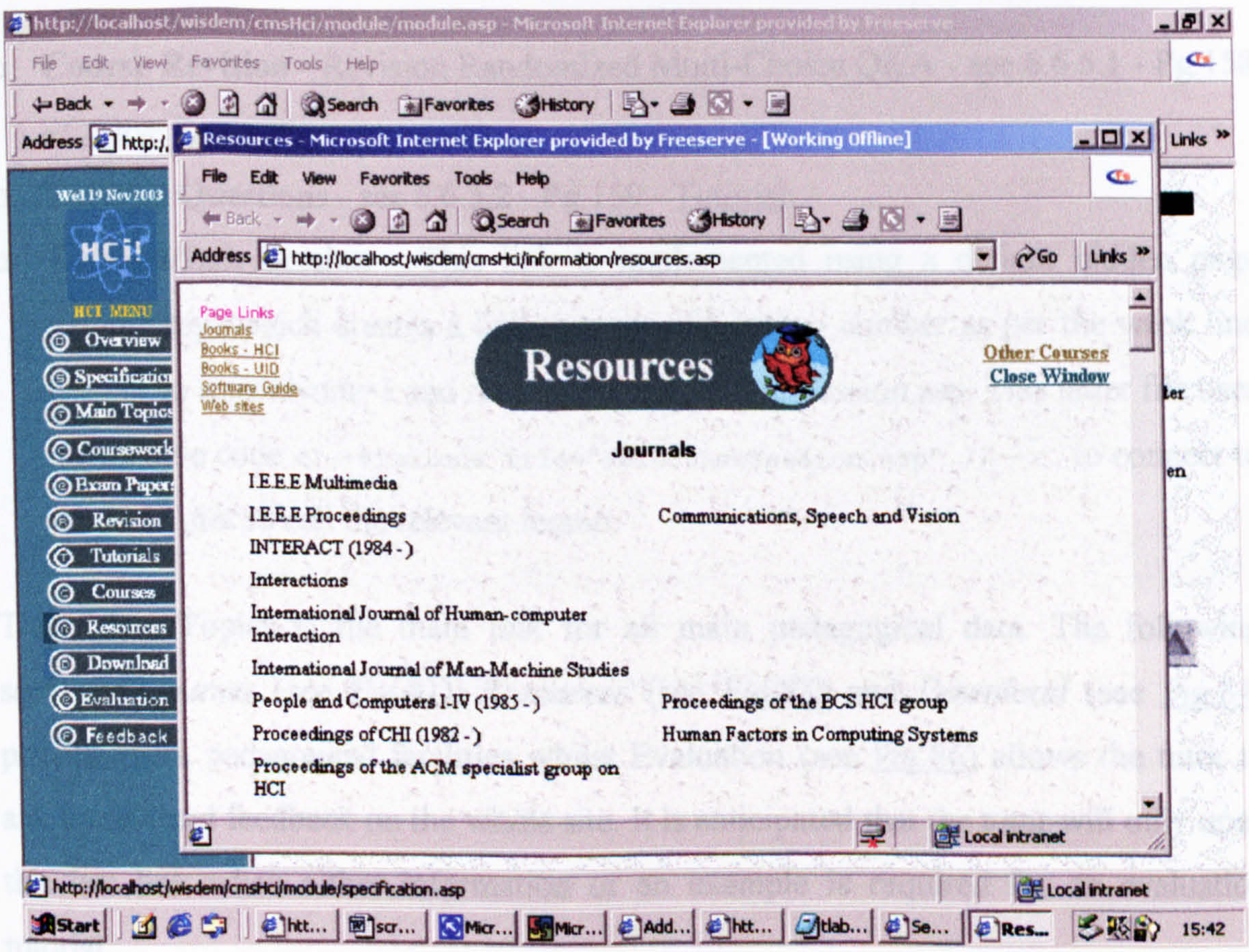


Figure 79 - General Resources - available from MENU and MAIN TOPICS

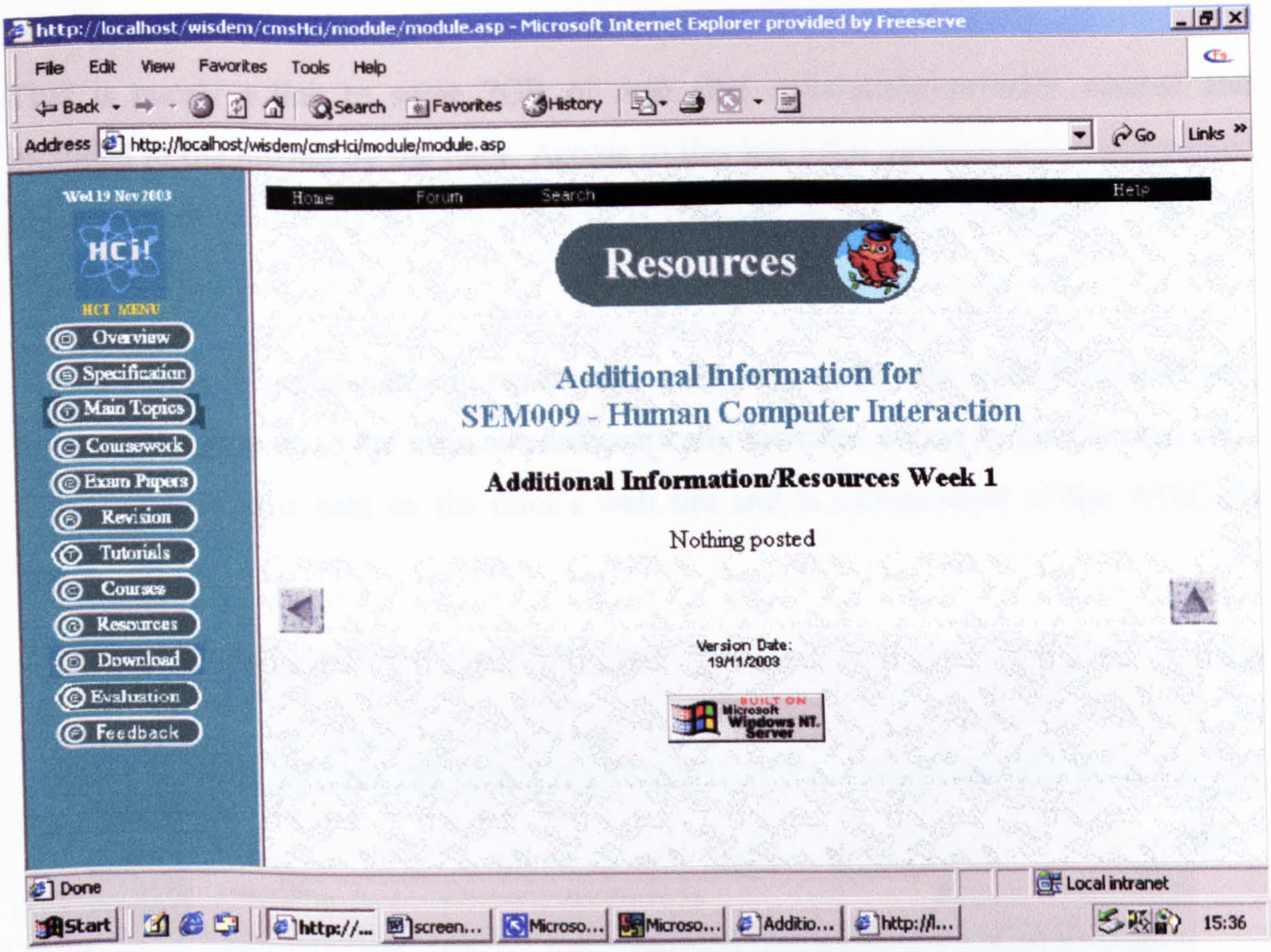


Figure 80 - Specific Resources

- **Course Revision** - Revision Randomized Multi-Choice Q&A - see 6.6.5.1 - Pg.158 - Course Revision.
- **Tutorial Questions** - see 6.6.5.2 - Pg.159 - Tutorial.
- **Tutorial/Lab Session** - This link is implemented using a default hidden page (lablink.asp) which creates a link to a specific lesson number as per the week line used or to lessonNum=1 and redirects to tutorialLabSession.asp. This latter file uses the include code `<!--#include file="selectLabSession.asp" //-->` to connect to wisdemTutor to call the relevant lesson.

Thus Main Topics is the main link for all main pedagogical data. The following sections: *Courses* (see Fig.81), *Resources* (see Fig.83) and *Download* (see Fig.84) provide extra pedagogical facilities whilst Evaluation (see Fig.86) allows the tutor to ask for stylized feedback on the whole site. It is anticipated that the tutor will only open this last link when either information or an example is required for an evaluation tutorial.

6.6.4.4 Courses

This is purely a link to some 7GB of web sites previously/currently created and included in the linking by the tutor. Access to this has been updated and implemented for access either directly when a login in is required or via the Resources page (see Fig.81 & Fig.82).

Logon access is implemented in exactly the same way as for the main WISDeM site; however, logging on to the main site automatically provides access to the Courses web. The courses web is held on the tutor's web site and is independent of the WISDeM webs.

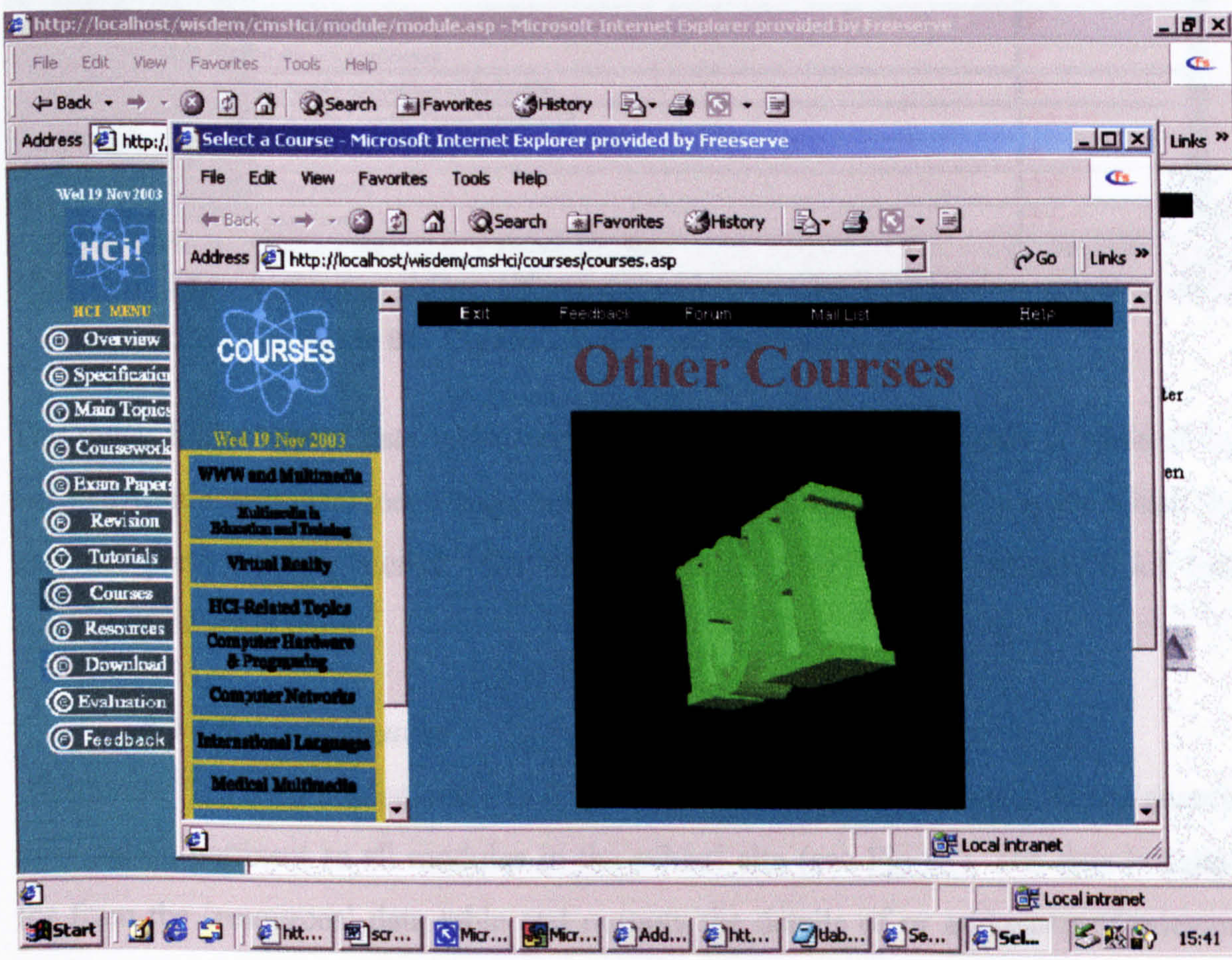


Figure 81 - Courses front page

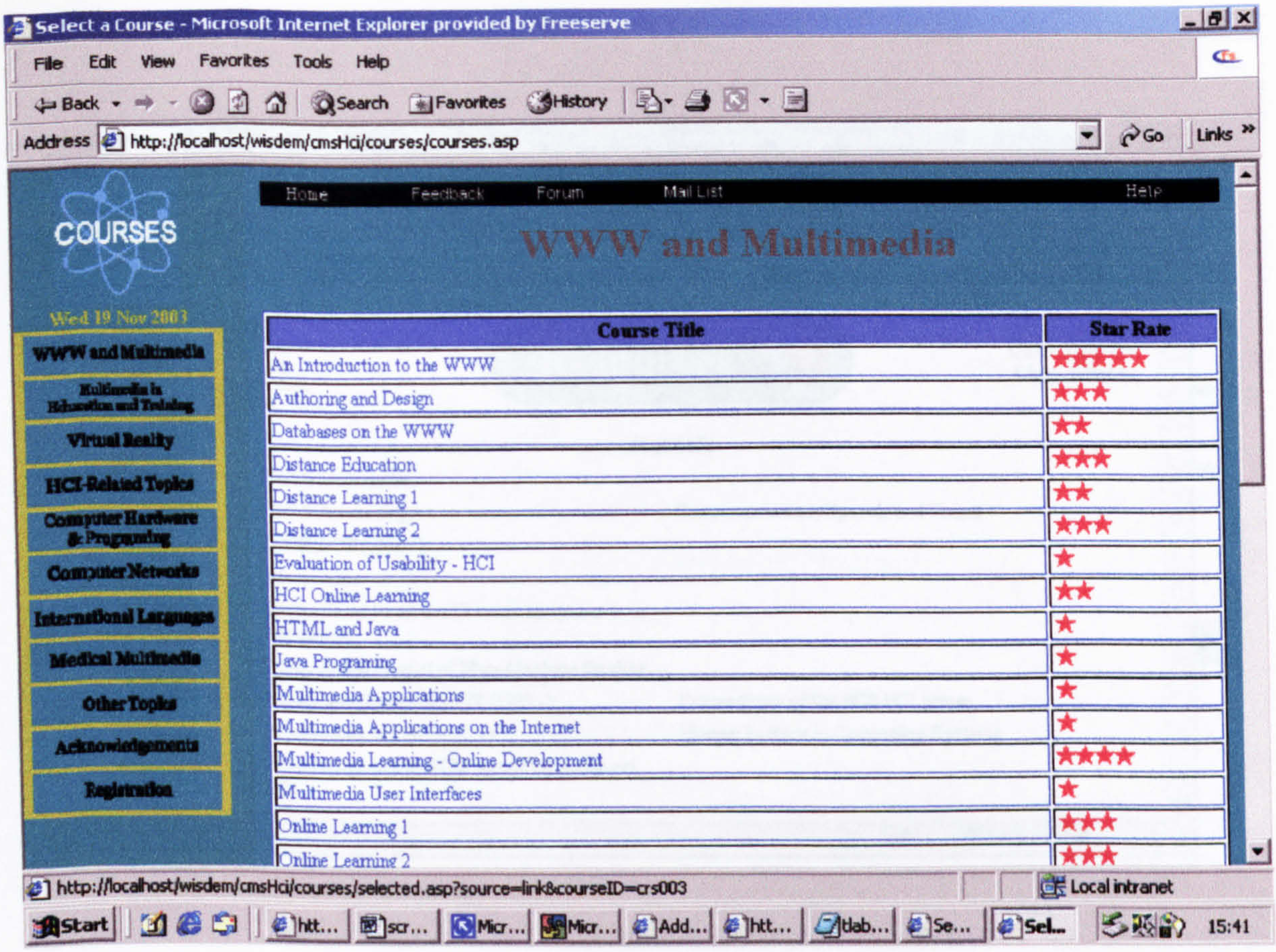


Figure 82 - Courses - WWW and Multimedia links.

The menu frame uses a data table '*courseMenu*' for information - this is updated by wisdemAdmin web. The menu page only provides links to those sections for which the user has previously registered - the student user has links to all sections. Each link opens a menu front page.

6.6.4.5 Resources

'Resources' has been implemented to output information specific to module and generic information pertinent to all modules in the school site (see Fig.83). The data is called for from the 'resources' data table and outputs the details of or addresses of relevant Journals, Books and Websites. It also provides the student with a link to the 'Other Course' web sites discussed in Courses above.

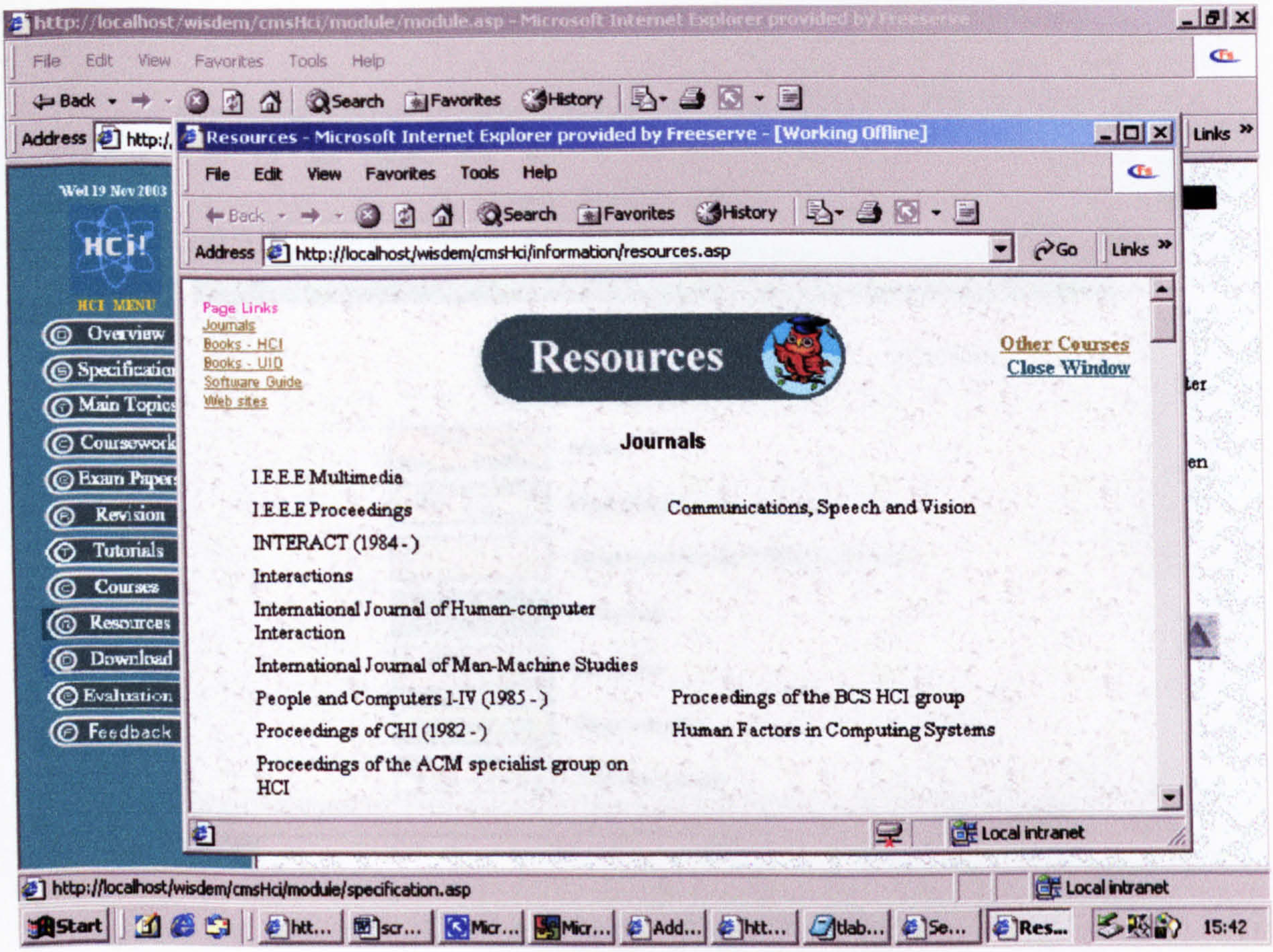


Figure 83 - Resources Page

6.6.4.6 Download

Download was implemented to provide the student with generic downloads and uses DHTML (Dynamic HTML) to provide messages for mouseover events, see following code and Fig.84:

```
<style type="text/css"><!--.white{color:#ffffff;}
#bwDiv{position:absolute; padding-left:10; left:8; top:10; width:100%;
height:16; clip:rect(0,100%,16,0);background-color:#000000; layer-
background-color:#000000; font-size:10pt; color:#ffffff;}--></style>
</head>

<body background="../images/background/paper.jpg" bgcolor="#FFFFFF"
topmargin="0" leftmargin="10" bgproperties="fixed">
<div id="bwDiv"><span class="white">

<p>When you pass your MouseOver a link this banner will describe the
link.</span></p>
</div>
```

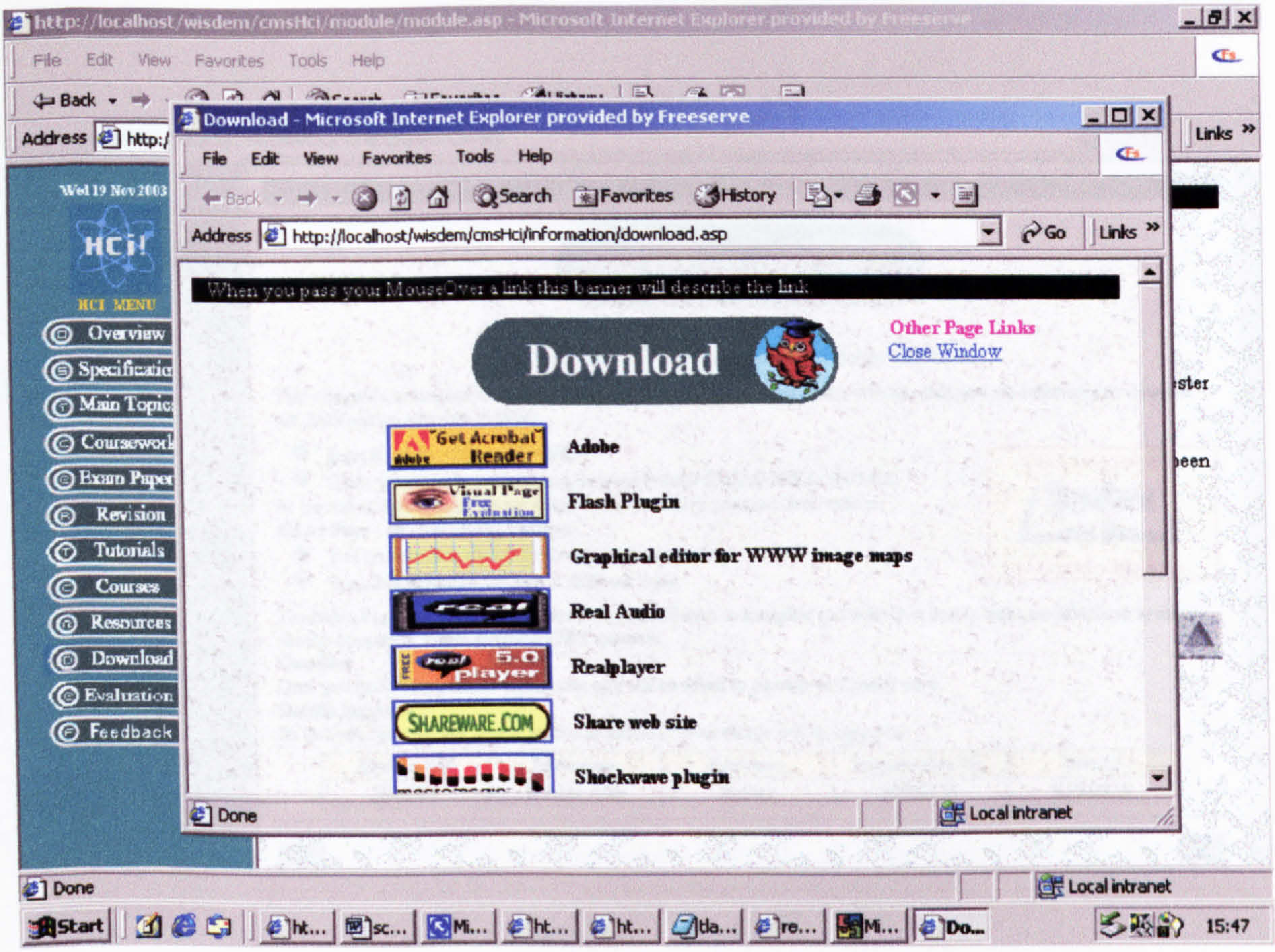


Figure 84 - Download page

6.6.4.7 Evaluation

The 'evaluation folder' within the 'module folder' has been implemented with 6 pages: confirmation.asp, index.asp, intro.asp, question.asp, store.asp and viewAnswer.asp.

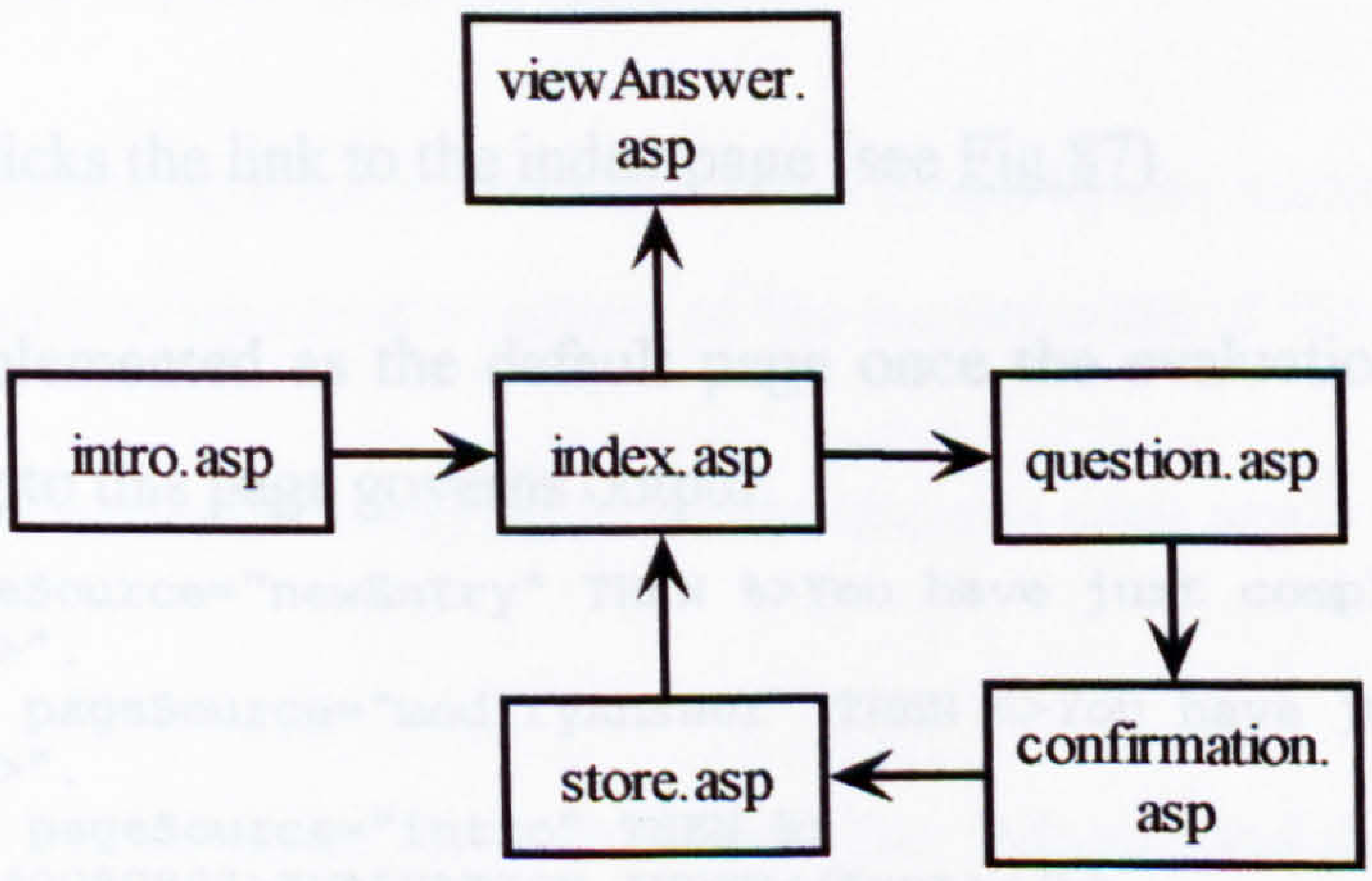


Figure 85 - Evaluation flow chart

See Fig.85 for the way the student is taken through the evaluation.

He/she opens the *intro.asp* page (see Fig.86)

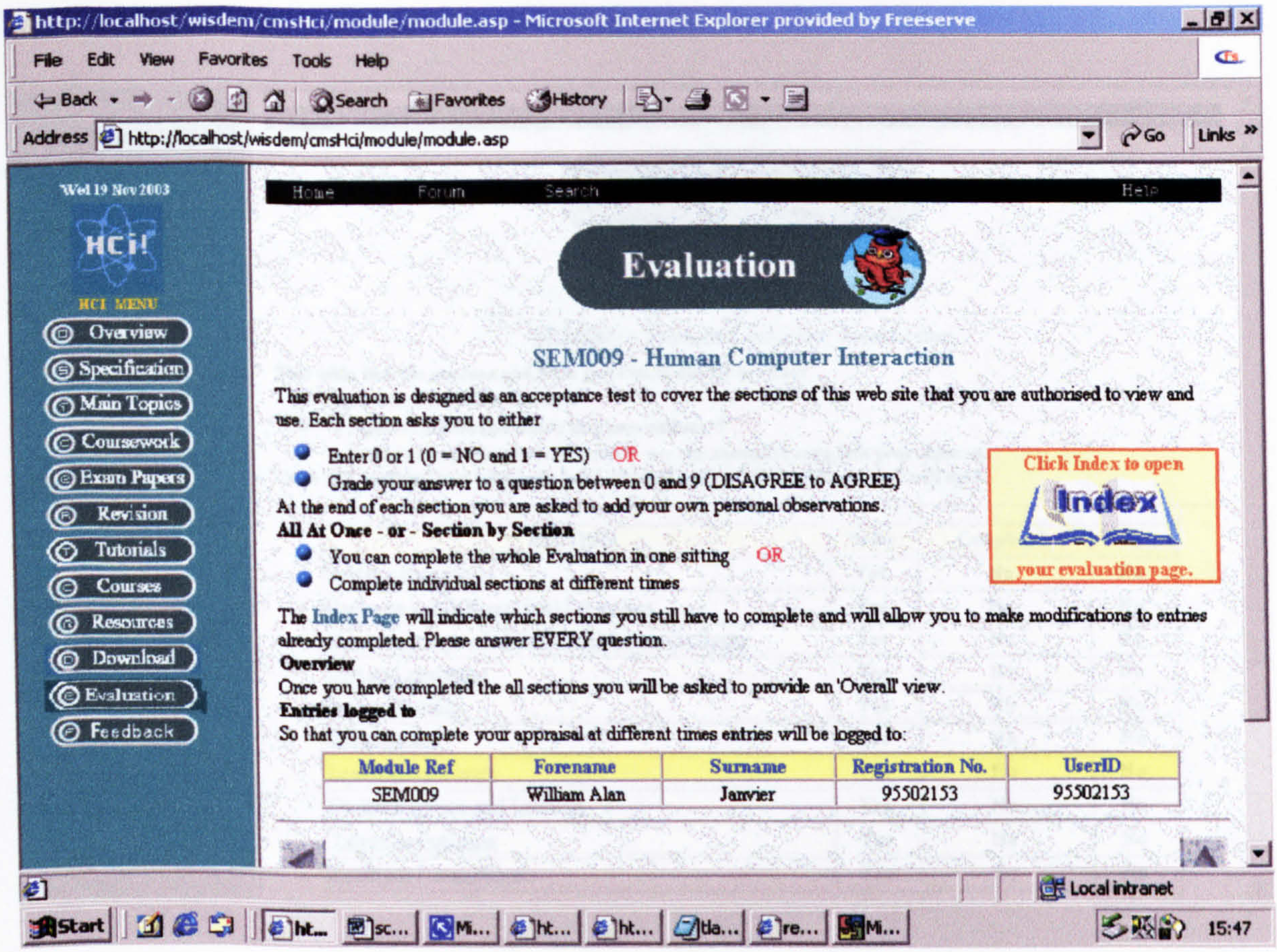


Figure 86 - Evaluation front page

This provides full information about the evaluation format and the fact that each section can be completed at different times. This page is implemented to output to the student his/her coordinates to indicate that the feedback to be provided will in fact be traceable to the student entering the information.

The student then clicks the link to the index page (see Fig.87)

This has been implemented as the default page once the evaluation has started. The page that is linking to this page governs output:

```
<%      IF pageSource="newEntry" THEN %>You have just completed
"<%=lastSection%>".
<%      ELSEIF pageSource="modifyAnswer" THEN %>You have just modified
"<%=lastSection%>".
<%      ELSEIF pageSource="intro" THEN %>
<b><font color="#008080">EVALUATION INDEX</font></b>
<%         END IF %>
```

This ensures that the student is receiving constant confirmation of his/her current position.

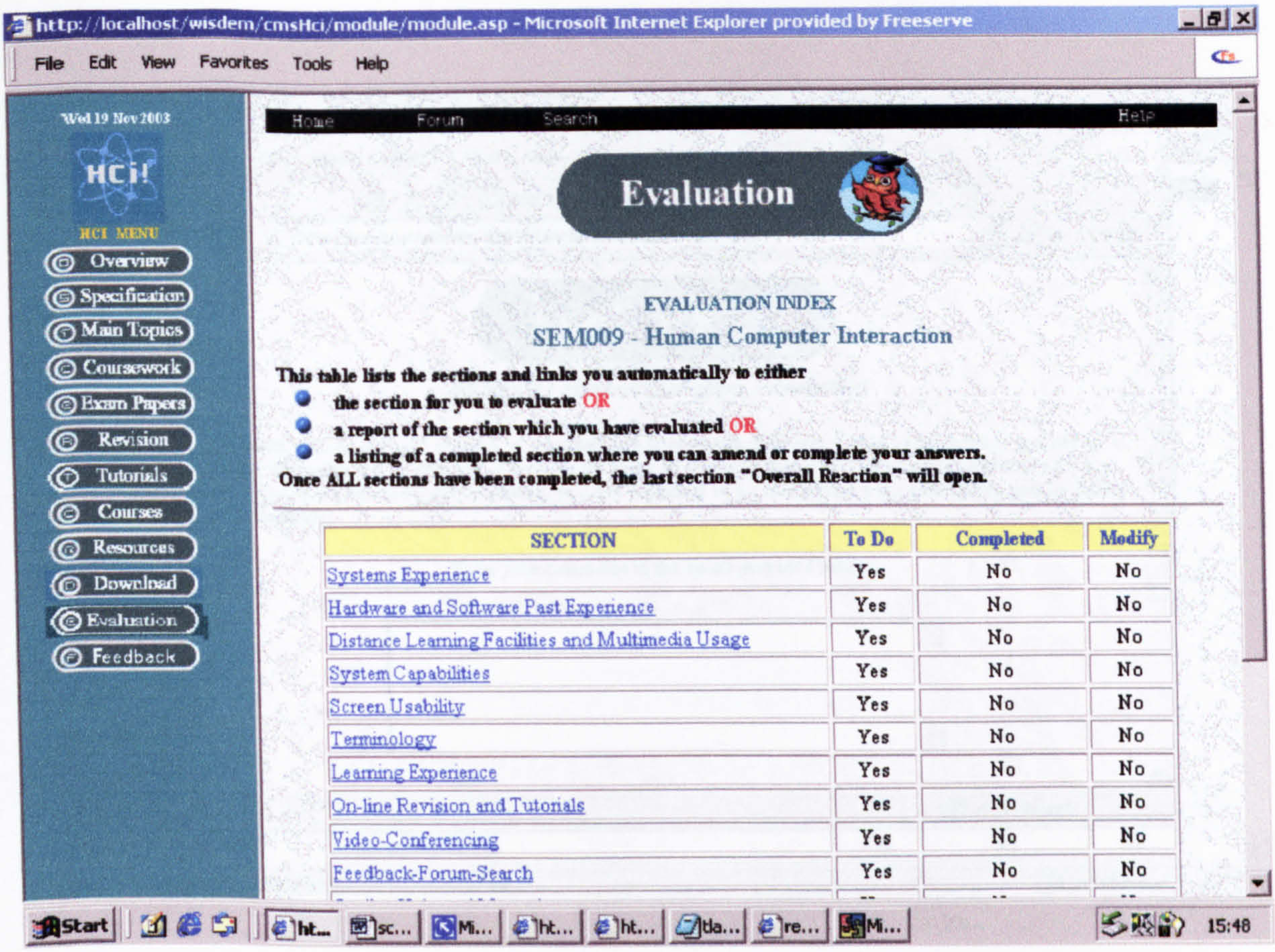


Figure 87 - Evaluation Index page

Once a section is completed the following changes have been implemented:

- **Section** - the hyperlink is removed
- **To Do** - changes to NO
- **Completed** - changes to a hyperlinked View Answer
- **Modify** - changes to a hyperlinked Modify

These changes allow the student to amend entries made to any section required; it also provides him/her with an up-to-date picture of the current state of the evaluation.

The active page that stores all feedback in the database is store.asp.

6.6.4.8 Feedback

Feedback has been implemented for both the Module web site and the Courses web site. The module feedback refers to the current module the student is using. Both types have been created using three files for the student - *add.asp, confirm.asp* and *module.asp* or *course.asp* as relevant. The tutor has two further facilities - *reports.asp* and *student.asp* or *user.asp* as relevant.

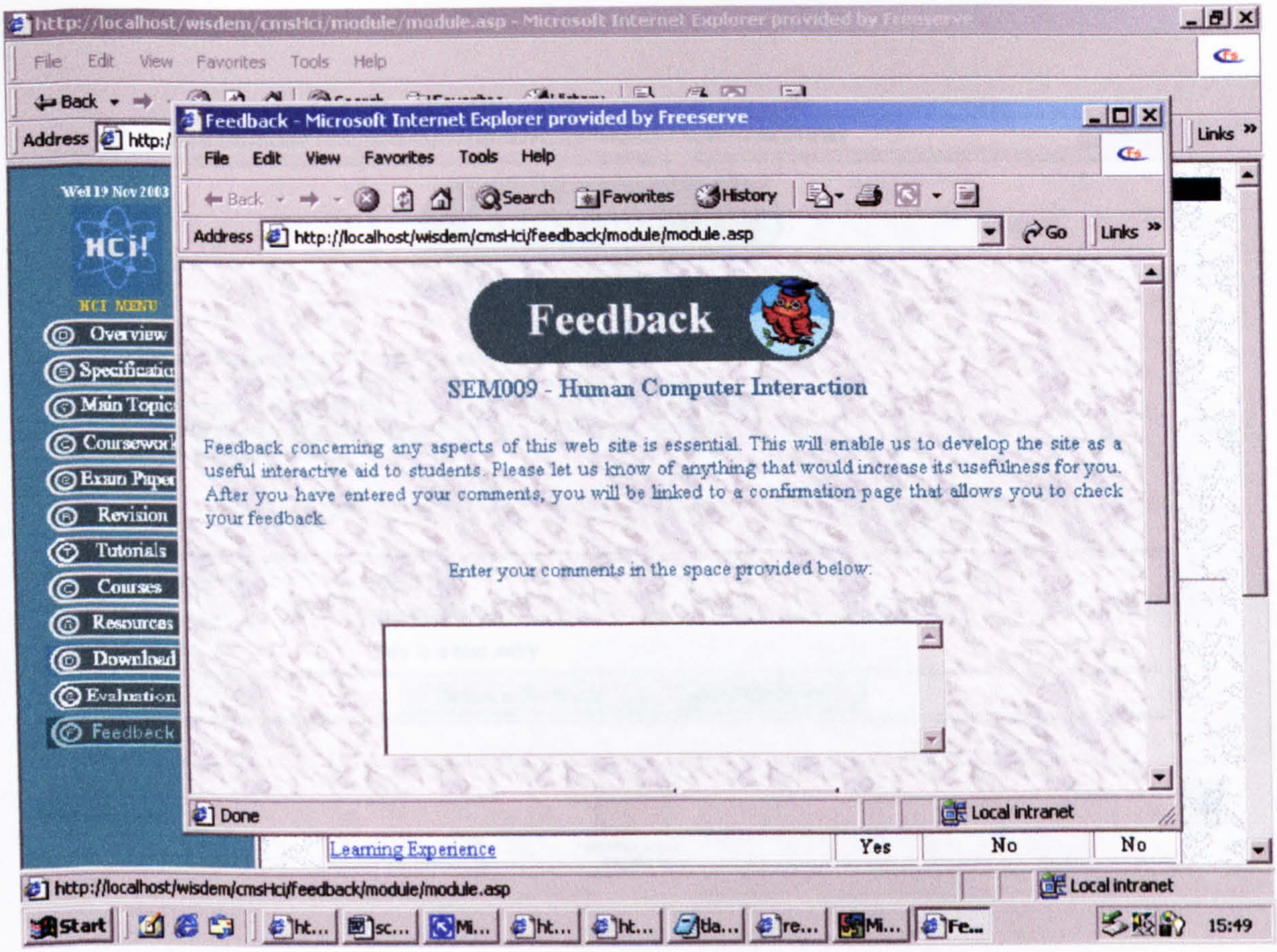


Figure 88 - Feedback page

Fig.88 shows the module output page that is designed to take feedback from the student.

Fig.89 shows the output to confirm the entry. This indicates to the student that the entry is traceable. The coding saves the student's ID, module, feedback provided and the current date as follows:

```
IF session("user")="" THEN
    response.redirect "../closeWindow.asp"
ELSE
    recCon.AddNew
    recCon("student_no")      =  session("user")
    recCon("module")          =  session("module")
    recCon("feedback")        =  request("feedback")
    recCon("date")            =  now()
    recCon.UpDate

    response.redirect "module.asp?thanks=fbok"
END IF
```

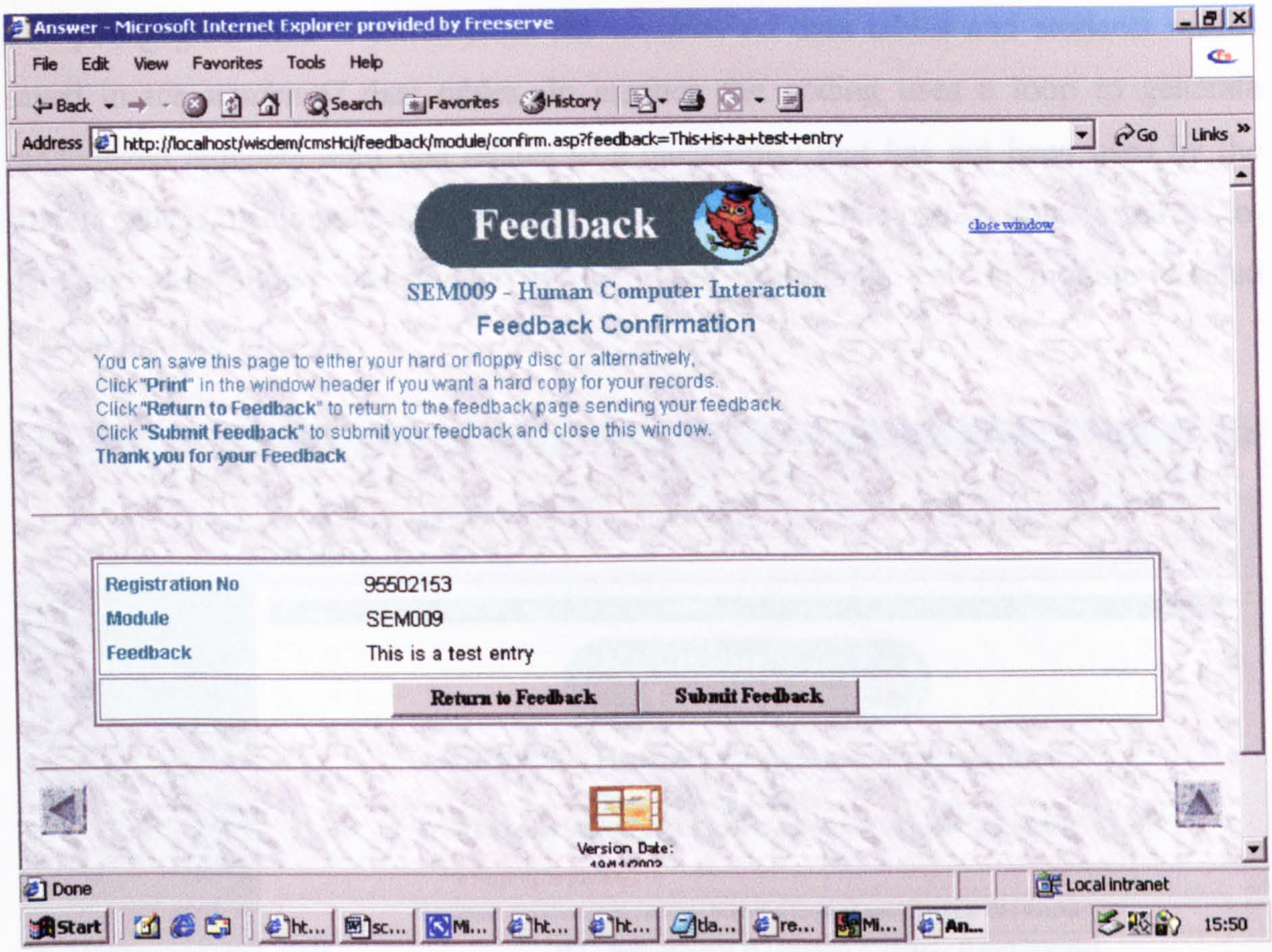


Figure 89 - Feedback Confirmation page showing a test entry

In the event that the session variable identifying the user has time-lapsed, no data is entered into the database and a close window page is output. Thus the posted feedback can be specifically identified to a particular student.

6.6.5 Tutorials - Course Revision and Tutorial

The default facilities also provide the tutor with normal online tutorials - Course Revision and Tutorial.

6.6.5.1 Course Revision

The intuitive interactive part of this facility is discussed in 6.7 Year 3 onwards (Pg.161), this section discusses Course Revision (see Fig.90). Course Revision was implemented to enable a student to test his/her knowledge retention by providing a random question facility drawn from the whole module. As such it does not provide the feedback or interactivity of Topic Learning (Pg.168) or Topic Testing (Pg.175); however, it was implemented to provide the facilities to 'view the correct answer', 'restart the revision', 'view an analysis report', 'open help specific to revision', 'see the answers for a specific topic', 'submit an answer', and 'get the next question'.

The pedagogical data is called from the *wisdemPed* data tables and students results saved in the *wisdemAI* data tables. In essence the coding uses a loop to generate randomized numbers until one relates to a questionID that has not been used by the student, this is then output together with linking answers. The page outputs progress to-date and thus allows the student to run a self-examining test on module-retained knowledge (see Fig.90).

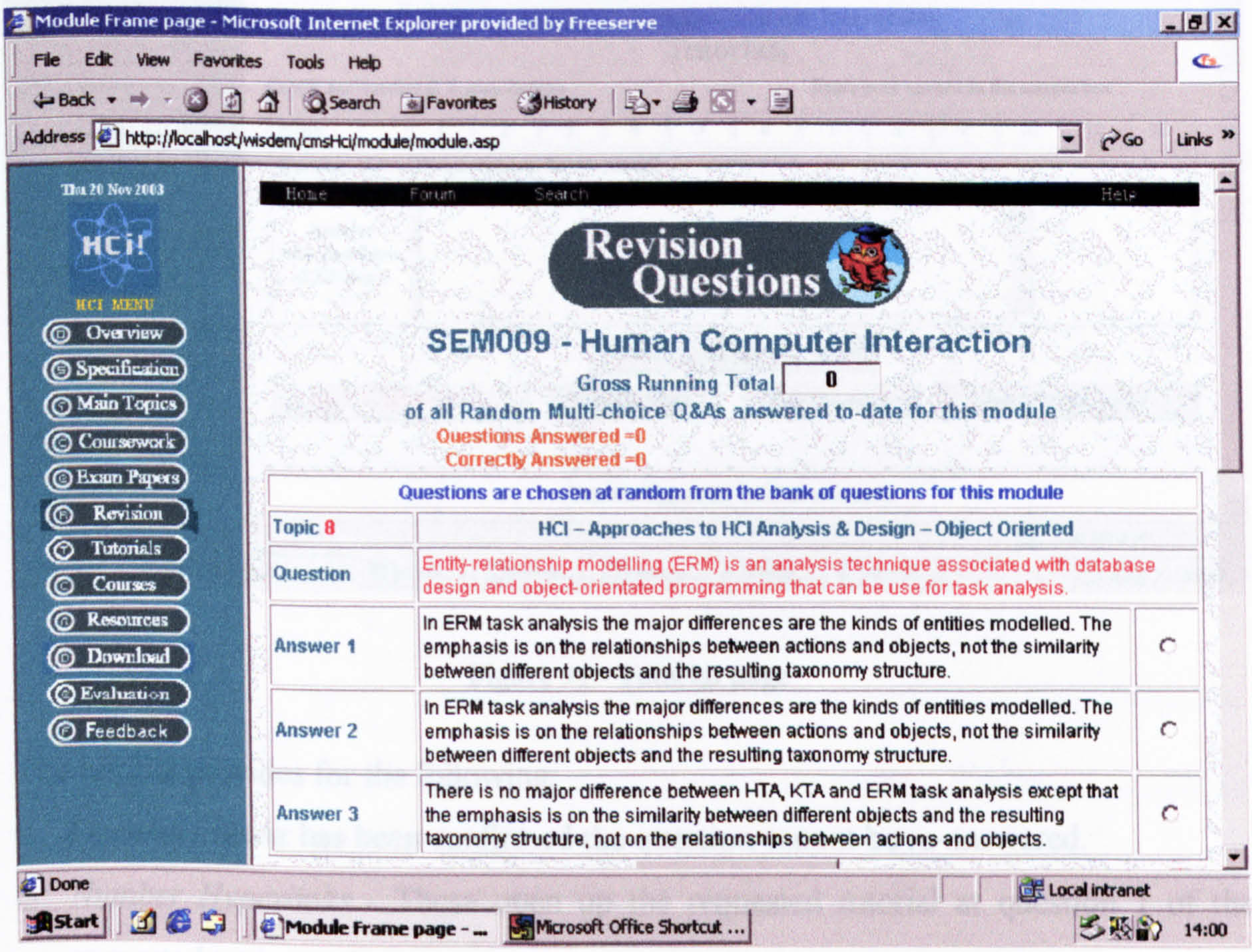


Figure 90 - Course Revision

6.6.5.2 Tutorial

The tutorial facility is accessed either from the Menu or from Main Topics (see Fig.91). It offers the student facilities to answer questions posted by the tutor for a specific topic. The data tables are held in 'wisdemPed' and consist of:

- TTquestion_module - this table allows the tutor to link any number of questions, topic/s and week/s and allocate the maximum percentage of marks to each question.
- TTquestion - this table creates a tutorial question ID to a textual question entry.
- TTanswer - this table inserts a student ID, his/her answer, identifies the module ID, topic number and question ID and also records the date and time the entry was made. There is a facility for the tutor to add a mark for the posted answer.

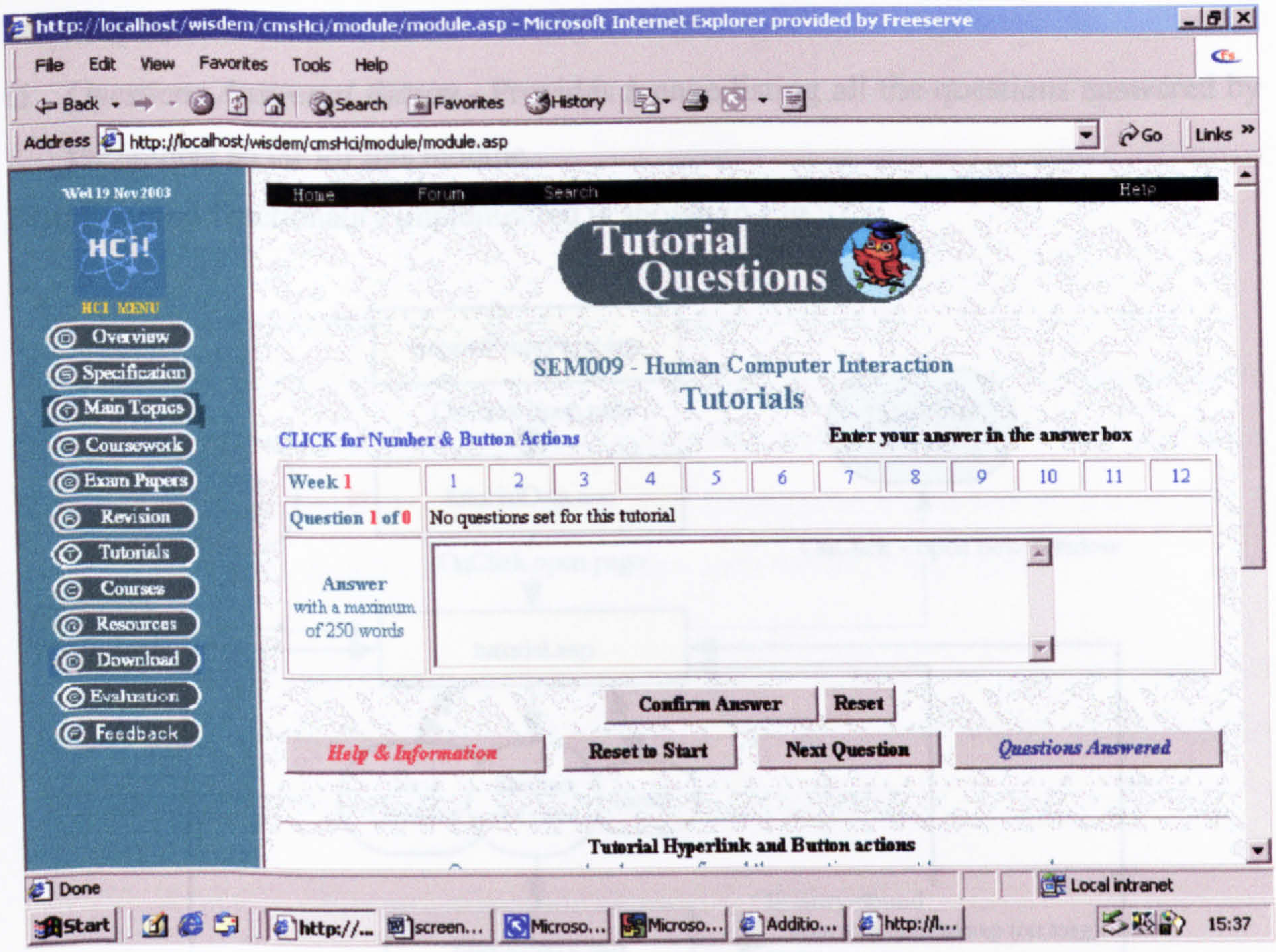


Figure 91 - Tutorial page

The tutorial provides for the following:

- Once an answer has been confirmed the question cannot be re-answered.
- *Number Hyperlinks* - These open up the requested tutorial at question 1 of the requested topic number.
- *Confirm Answer button* - Transfers the student's question and answer to a confirmation page where he/she can:
  - Print-out the question and answer
  - Submit the answer
  - Return to question/answer page to alter the answer
- *Reset button* - Cancels the entry and resets the answer box.
- *Help Information button* - Provides a 'Help' on the use of both types of Revision (Week & Course) and for the Tutorial Questions.
- *Reset to Start button* - Resets the whole page to Question 1, Week 1 of the current module.

- *Next Question button* - Loads next question or, if relevant, the 1st question of the next Tutorial.
- *Questions Answered Button* - Provides a page listing all the questions answered by the student so far for this module.

The flow and functionality implemented is shown in Fig.92.

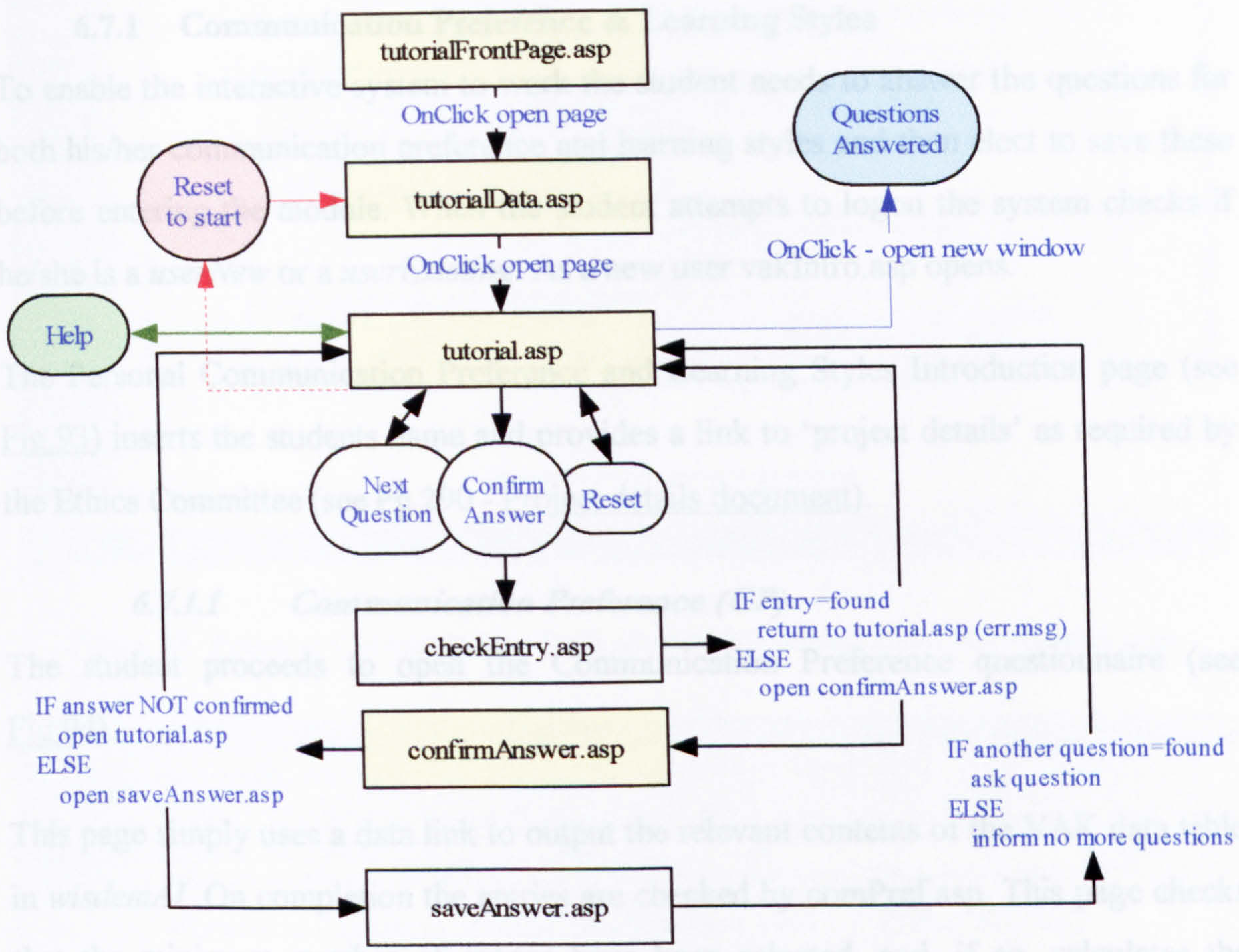


Figure 92 - Tutorial flow chart

6.7 Year 3 onwards – Intuitive Interactive Section - Multi-choice Q&A

This section was implemented during the third year onwards. It includes: Communication Preference, Learning Styles, and Multi-choice Topic Learning and Topic Testing Q&A. The intuitive interaction is implemented in fifty pages in the *wisdemCPLS* web and the revision folder in the *wisdem* web: the pages contain 369 rules[54] and 964 conditions[55]: it is coded in ASP using ODBC linking to 19 Access data tables in *wisdemAI*, 17 data tables in *wisdemPed* and 3 data tables in *cmshci* (staff and

[54] A rule consists of an instruction to the system to open database connectivity to a specific data table, to save data, to delete data, to amend data or to close the database connectivity and clear the CPU memory.

[55] A condition consists of the instruction to the system to only perform the save, amend, delete, select provided a specific case or set of cases exist

student coordinates). On the first entry the student establishes his/her Communication Preference and Learning Styles; thereafter, he/she uses the interactive Revision Multi-choice Q&A. Fig.30 (Pg.84) shows the flow implemented for a student logging on to WISDeM and Fig.31 (Pg.85) shows the flow implemented when the student completes the two psychometric tests.

6.7.1 Communication Preference & Learning Styles

To enable the interactive system to work the student needs to answer the questions for both his/her communication preference and learning styles and then elect to save these before entering the module. When the student attempts to logon the system checks if he/she is a *userNew* or a *userExisting*. As a new user vakIntro.asp opens.

The Personal Communication Preference and Learning Styles Introduction page (see Fig.93) inserts the students name and provides a link to 'project details' as required by the Ethics Committee (see Pg.290 - Project details document).

6.7.1.1 Communication Preference (CP)

The student proceeds to open the Communication Preference questionnaire (see Fig.94).

This page simply uses a data link to output the relevant contents of the VAK data table in *wisdemAI*. On completion the entries are checked by comPref.asp. This page checks that the minimum number of entries have been selected, and, if so, calculates the weighting for Visual, Auditory or Kinaesthetic answers. The results are used for the next output or the student is returned to the questionnaire with an appropriate error message.

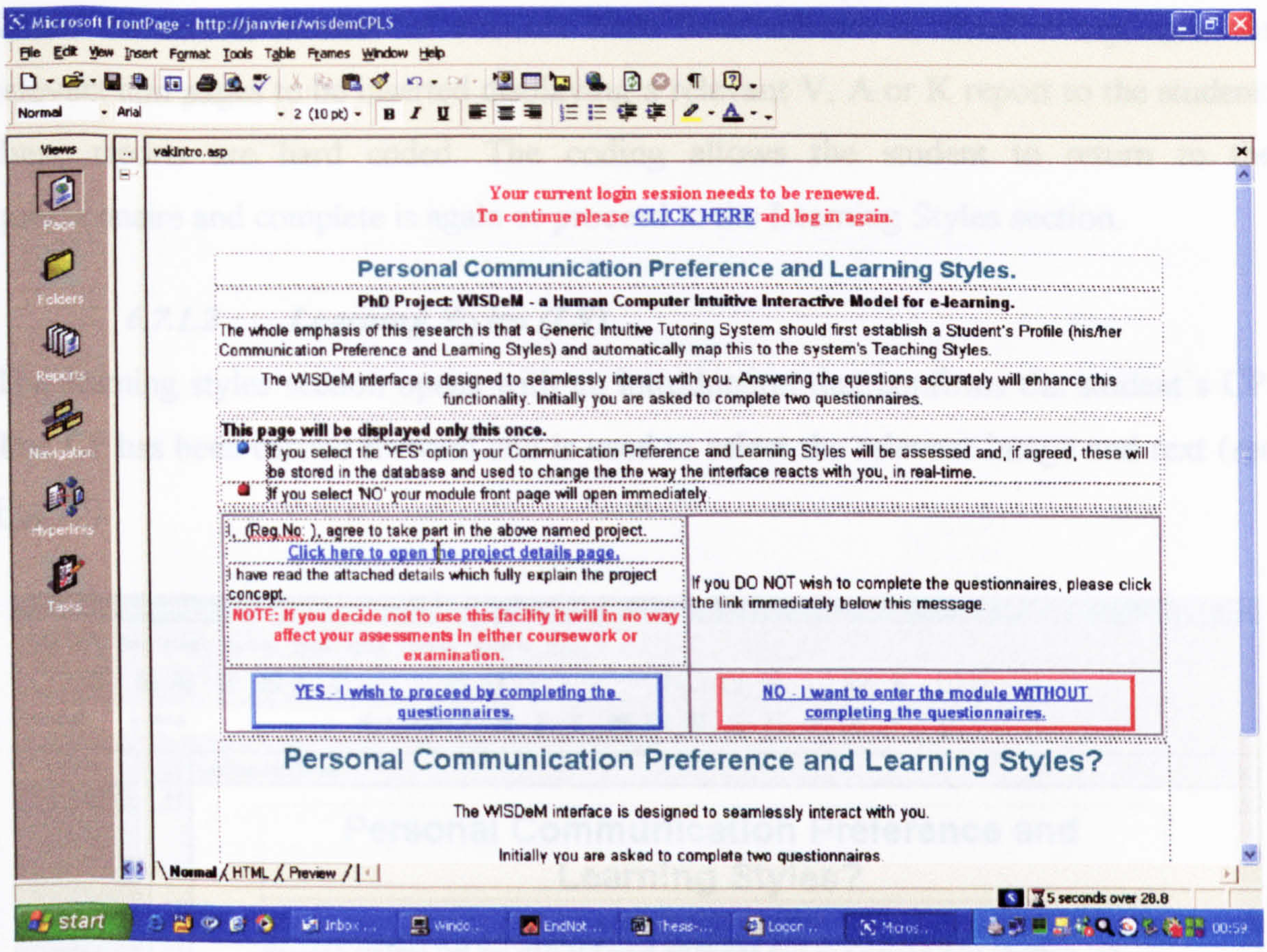


Figure 93 - Personal Communication Preference and Learning Styles Introduction page

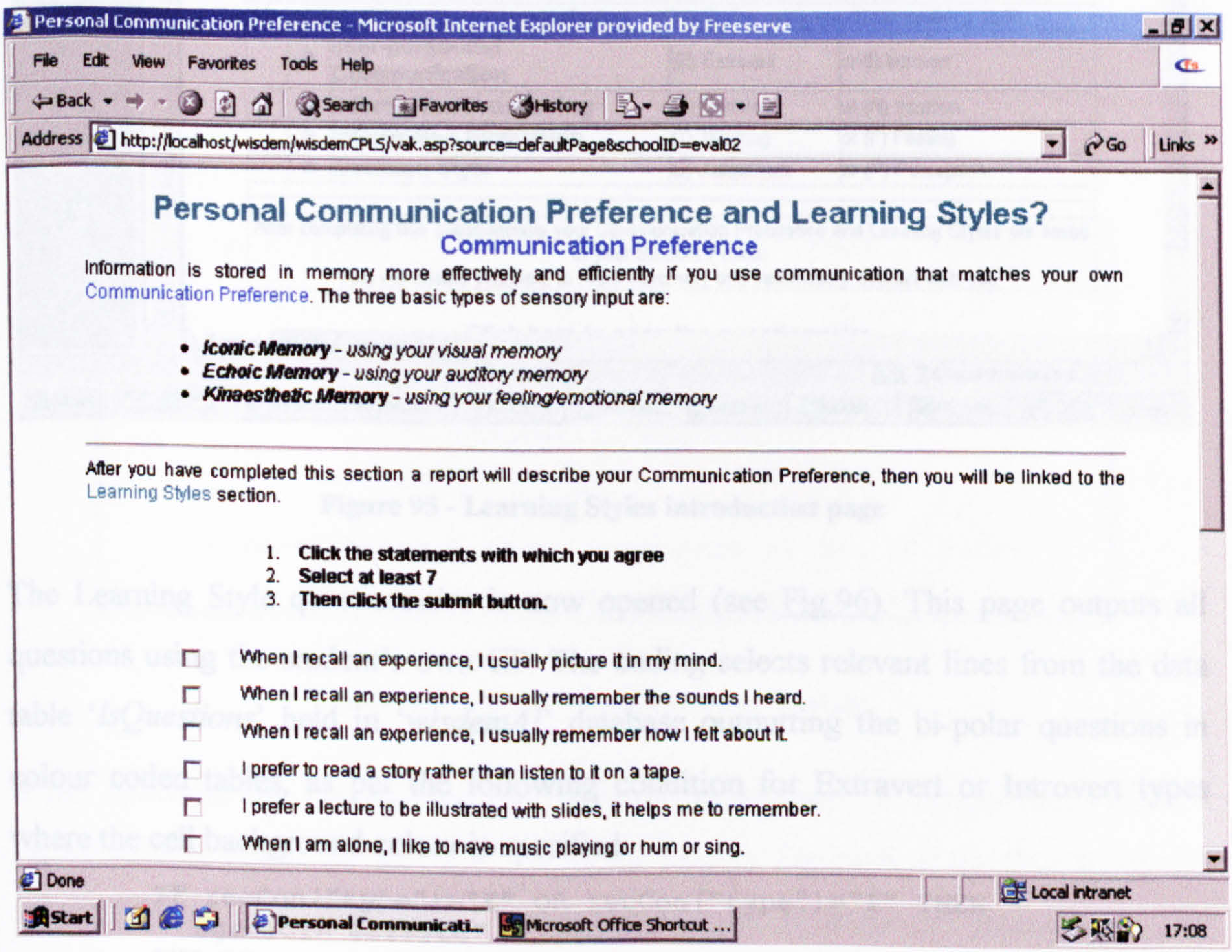


Figure 94 - Communication Preference screen

When the correct number of answers have been submitted, comPref.asp calls for relevant htm pages to be inserted displaying a relevant V, A or K report to the student: these reports are hard coded. The coding allows the student to return to the questionnaire and complete is again or proceed to the Learning Styles section.

6.7.1.2 *Learning Styles (LS)*

The learning styles section opens with an introduction that confirms the student's CP. The CP has been carried forward and is used to select the relevant image and text (see Fig.95).

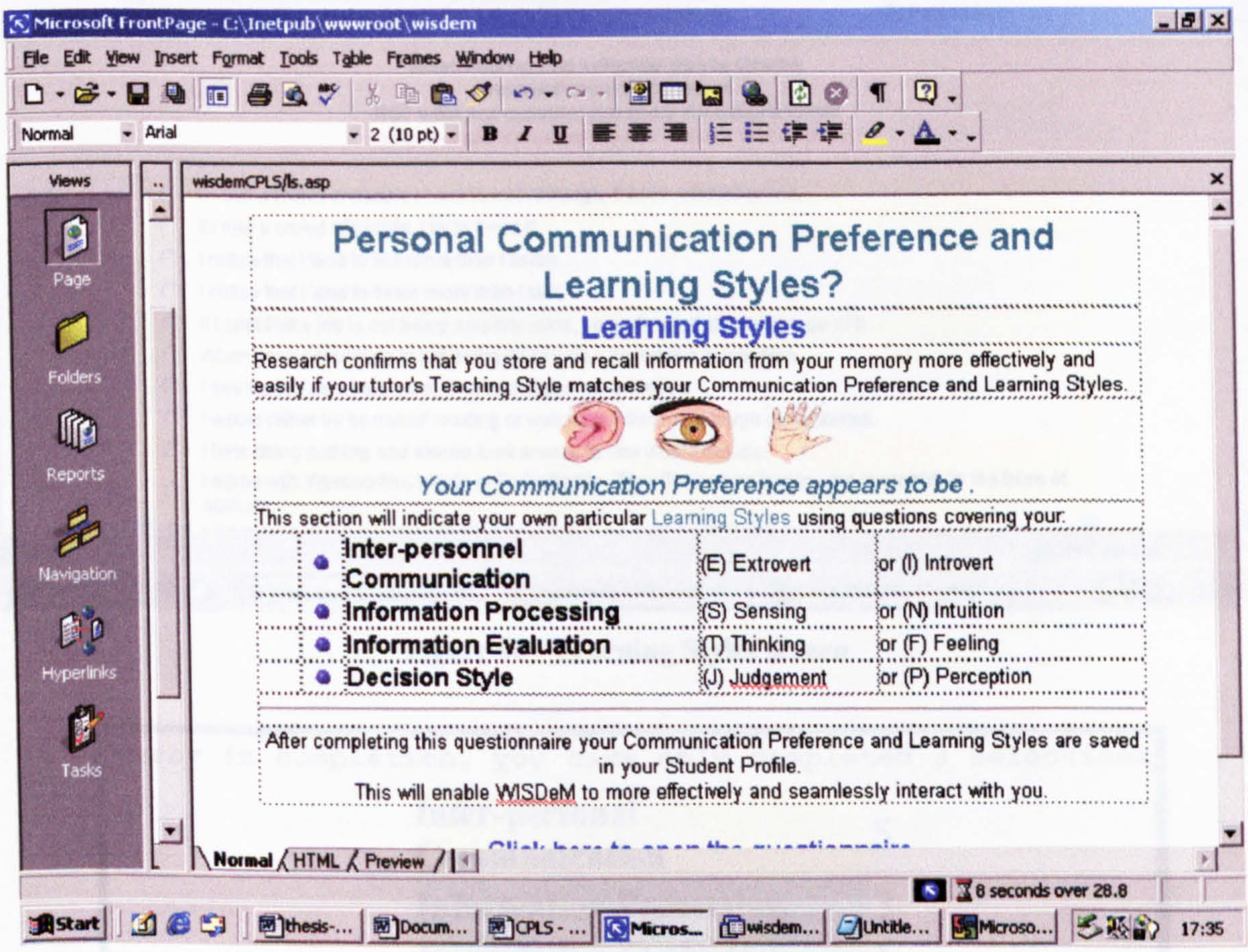


Figure 95 - Learning Styles introduction page

The Learning Style questionnaire is now opened (see Fig.96). This page outputs all questions using the student's own CP. The coding selects relevant lines from the data table '*lsQuestions*' held in '*wisdemAI*' database outputting the bi-polar questions in colour coded tables, as per the following condition for Extravert or Introvert types where the cell background colour is specified.

```
IF recCon("type")="E" OR recCon("type")="I" THEN
   bgcolor="#FFFFCC"
END IF
```

On submission of the answers the posted data is carried forward to lsReport.asp where the validity of the entries is checked. In the event of an error, an error message is displayed (see Fig.97).

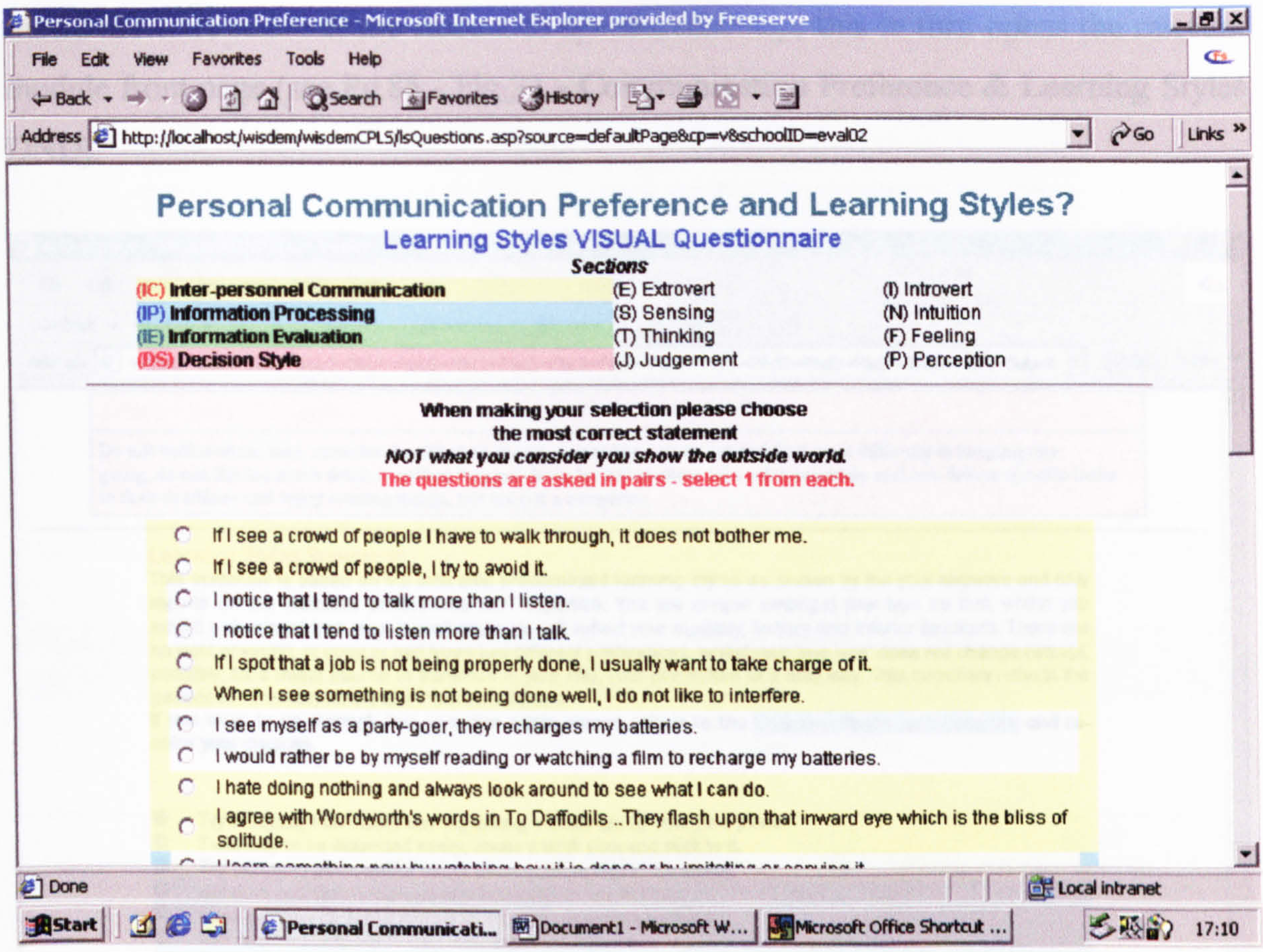


Figure 96 - Learning Styles screen

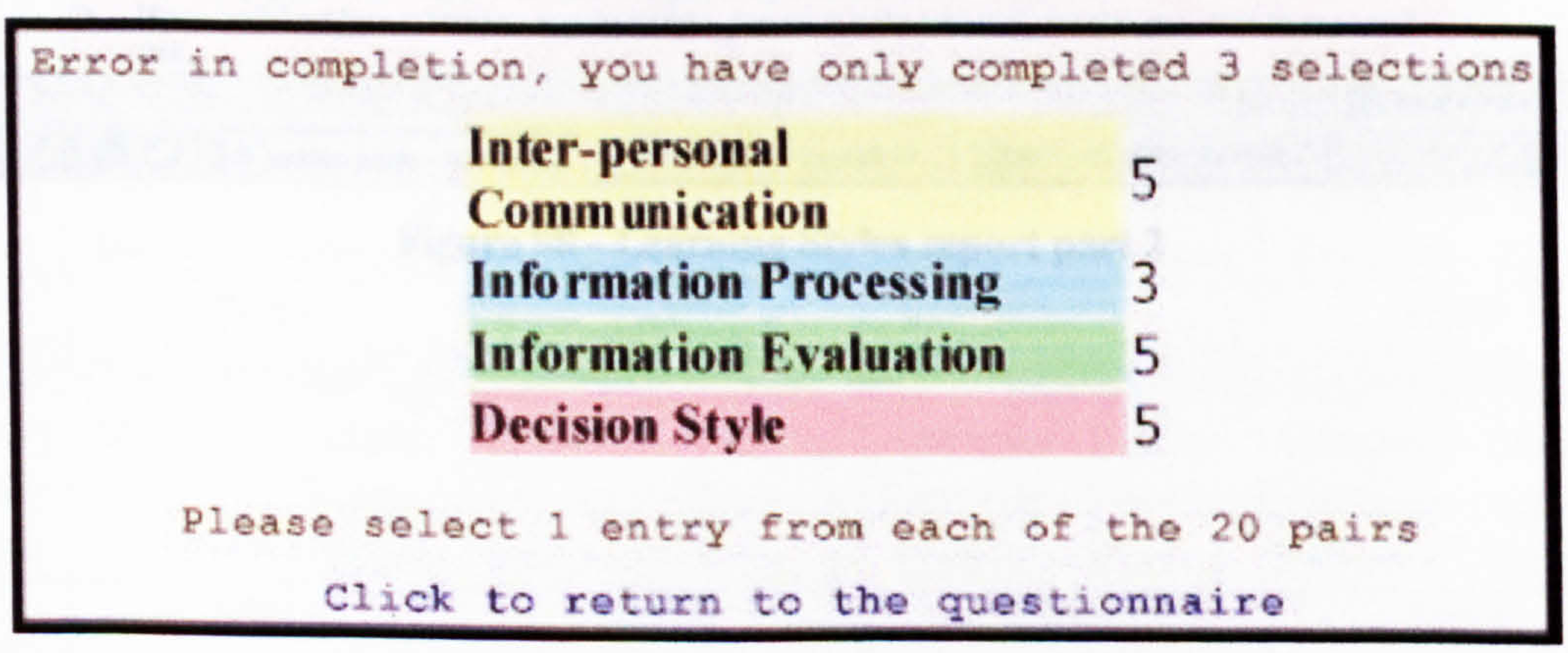


Figure 97 - Learning Styles Error Message

If the selections are correct then the Learning Styles report is output (see Pg.126 - Fig.57 for Pt1, Fig.98 for Part 2 & Fig.99 for Part 3). For each of the four styles, the report provides the student with: i) A numeric account, ii) A generic textual report, iii) A Learning Styles summary, and iv) A report on his/her Jungian functions (see

Fig.100). The student is provided with the facility to return to alter entries or proceed to the next stage.

The system now saves the CPLS data in the VAK data table in *wisdemAI* via *action.asp* where the code redirects the student to *openModule.asp,* this in turn opens the relevant module front page (see Pg.85 - Fig.31 - Communication Preference & Learning Styles DND).

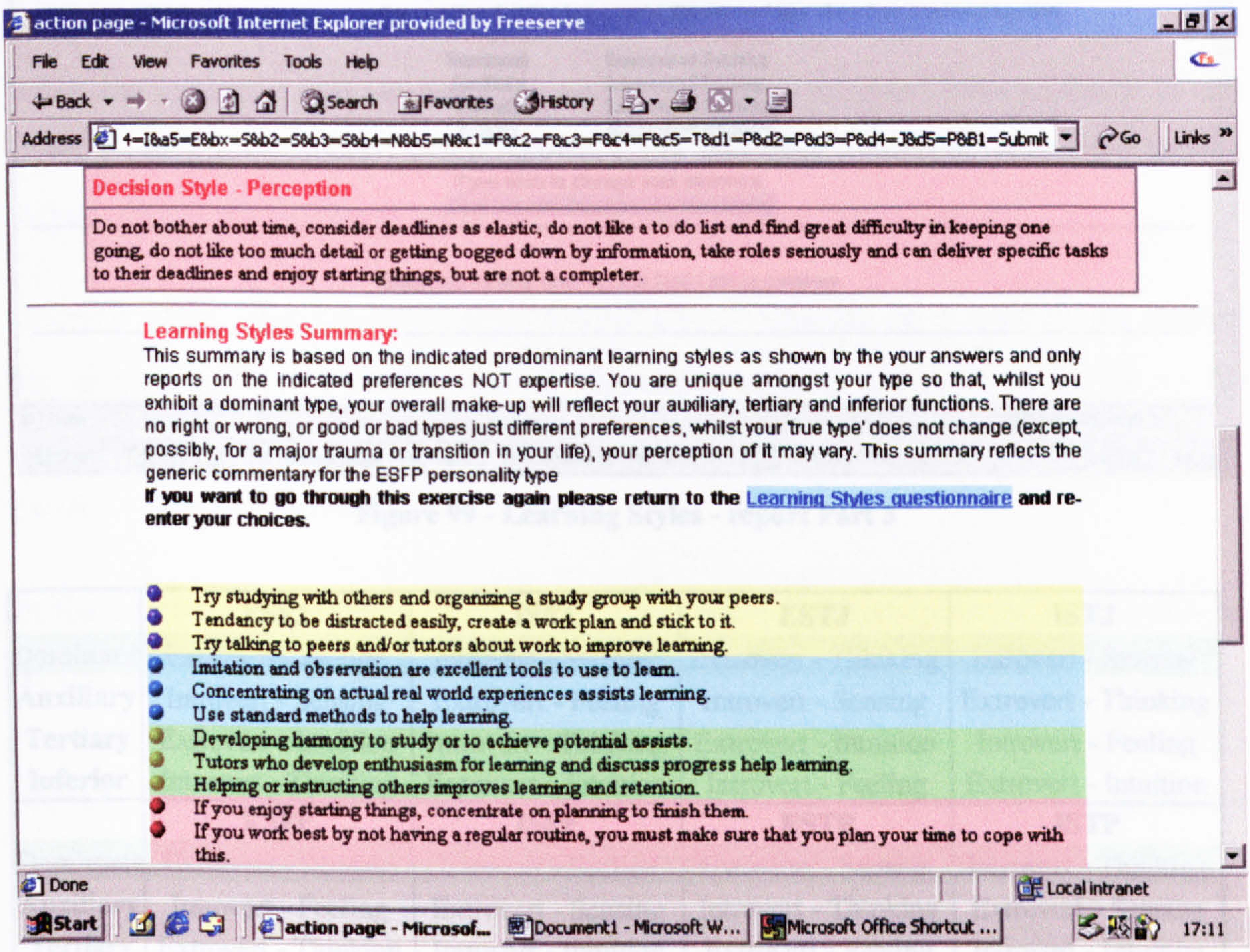


Figure 98 - Learning Styles report part 2

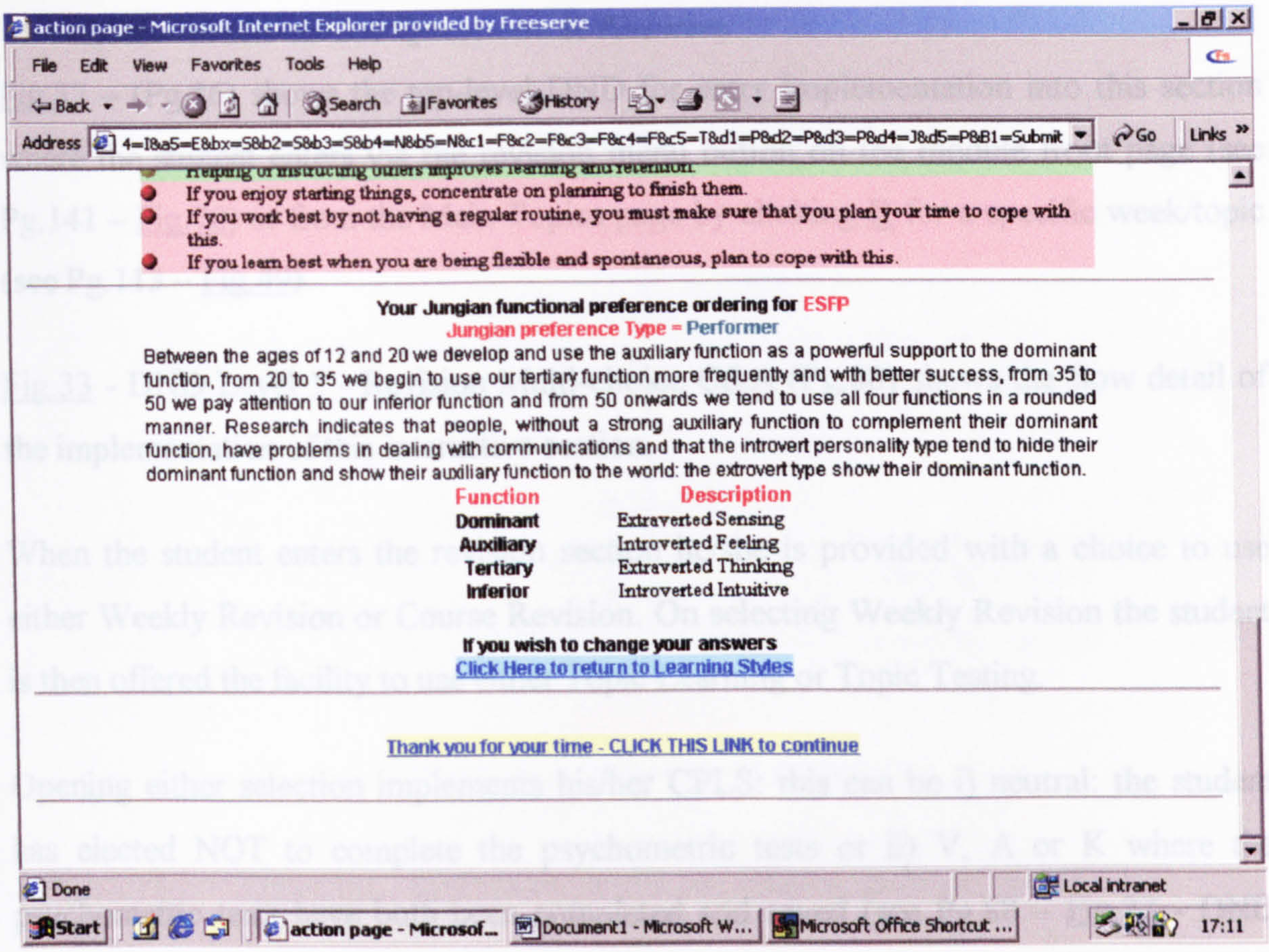


Figure 99 - Learning Styles - report Part 3

	ESFJ	ISFJ	ESTJ	ISTJ
Dominant	Extrovert - Feeling	Introvert - Sensing	Extrovert - Thinking	Introvert - Sensing
Auxiliary	Introvert - Sensing	Extrovert - Feeling	Introvert - Sensing	Extrovert - Thinking
Tertiary	Extrovert - Intuition	Introvert - Thinking	Extrovert - Intuition	Introvert - Feeling
Inferior	Introvert - Thinking	Extrovert - Intuition	Introvert - Feeling	Extrovert - Intuition
	ESFP	**ISFP**	**ESTP**	**ISTP**
Dominant	Extrovert - Sensing	Introvert - Feeling	Extrovert - Sensing	Introvert - Thinking
Auxiliary	Introvert - Feeling	Extrovert - Sensing	Introvert - Thinking	Extrovert - Sensing
Tertiary	Extrovert - Thinking	Introvert - Intuition	Extrovert - Feeling	Introvert - Intuition
Inferior	Introvert - Intuition	Extrovert - Thinking	Introvert - Intuition	Extrovert - Feeling
	ENFJ	**INFJ**	**ENFP**	**INFP**
Dominant	Extrovert - Feeling	Introvert - Intuition	Extrovert - Intuition	Introvert - Feeling
Auxiliary	Introvert - Intuition	Extrovert - Feeling	Introvert - Feeling	Extrovert - Intuition
Tertiary	Extrovert - Sensing	Introvert - Thinking	Extrovert - Thinking	Introvert - Sensing
Inferior	Introvert - Thinking	Extrovert - Sensing	Introvert - Sensing	Extrovert - Thinking
	ENTJ	**INTJ**	**ENTP**	**INTP**
Dominant	Extrovert - Thinking	Introvert - Intuition	Extrovert - Intuition	Introvert - Thinking
Auxiliary	Introvert - Intuition	Extrovert - Thinking	Introvert - Thinking	Extrovert - Intuition
Tertiary	Extrovert - Sensing	Introvert - Feeling	Extrovert - Feeling	Introvert - Sensing
Inferior	Introvert - Feeling	Extrovert - Sensing	Introvert - Sensing	Extrovert - Feeling

Figure 100 - Carl Jungian Functions related to the 16 Personality Types

(William Alan Janvier & Ghaoui, 2002a; William A. Janvier & Ghaoui, 2003b; Murphy et al., 2002; Wilson et al., 2002)

6.7.2 Multi-choice Questions & Answers

Fig.32 – (Pg.86) shows the top-level DND for entry implementation into this section where the student enters via the revision menu button on the module front page (see Pg.141 – Fig.70) or from the Main Topics page by clicking **R** for a specific week/topic (see Pg.113 – Fig.49).

Fig.33 - DND Level 1 - Revision Multi-choice Q&A (Pg.88) shows the flow detail of the implementation of this interactive section.

When the student enters the revision section he/she is provided with a choice to use either Weekly Revision or Course Revision. On selecting Weekly Revision the student is then offered the facility to use either Topic Learning or Topic Testing.

Opening either selection implements his/her CPLS: this can be i) neutral: the student has elected NOT to complete the psychometric tests or ii) V, A or K where the psychometric tests have both been completed and saved (see Pg.88 – Fig.33 - DND Level 1 - Revision Multi-choice Q&A).

In the event that the student elects NOT to complete the psychometric tests, he/she is routed by the system to the Module front page and continues to use the system; however, no intuitive interaction takes place in the Revision Multi-Choice Q&A section. The student will see the same multi-choice Q&A but without the interactive feedback, motivational comments or any of the other facilities offered by the CPLS linked system: he/she receives exactly the same type of output as experienced when using course revision (see Pg.159 – Fig.90).

6.7.2.1 Topic Learning and MAIN system algorithm

This section is accessed via *inputDataReveal.asp*. This page stores input data and outputs the required information for the Topic Learning page to be loaded.

Multi-choiceReveal.asp now loads the Revision Topics Learning the screen (see Pg.125 - Fig.56). This page is implemented to output Neurolinguistic Language Pattern textual headers for the header, question and answers using the calculated rfFactor and mqFactors (Fig.101).

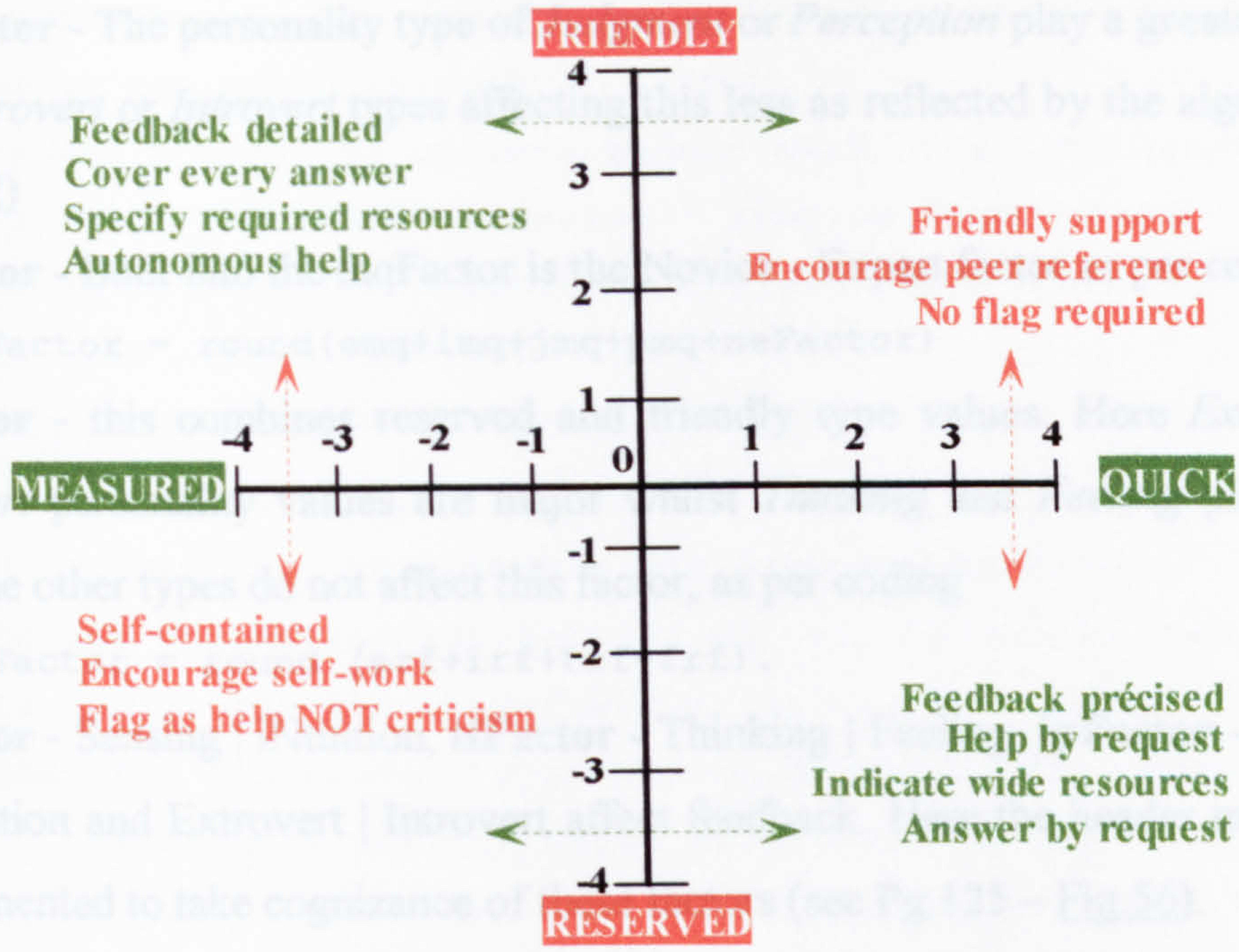


Figure 101 - The rfFactor, mqFactor, Nefactor feedback types

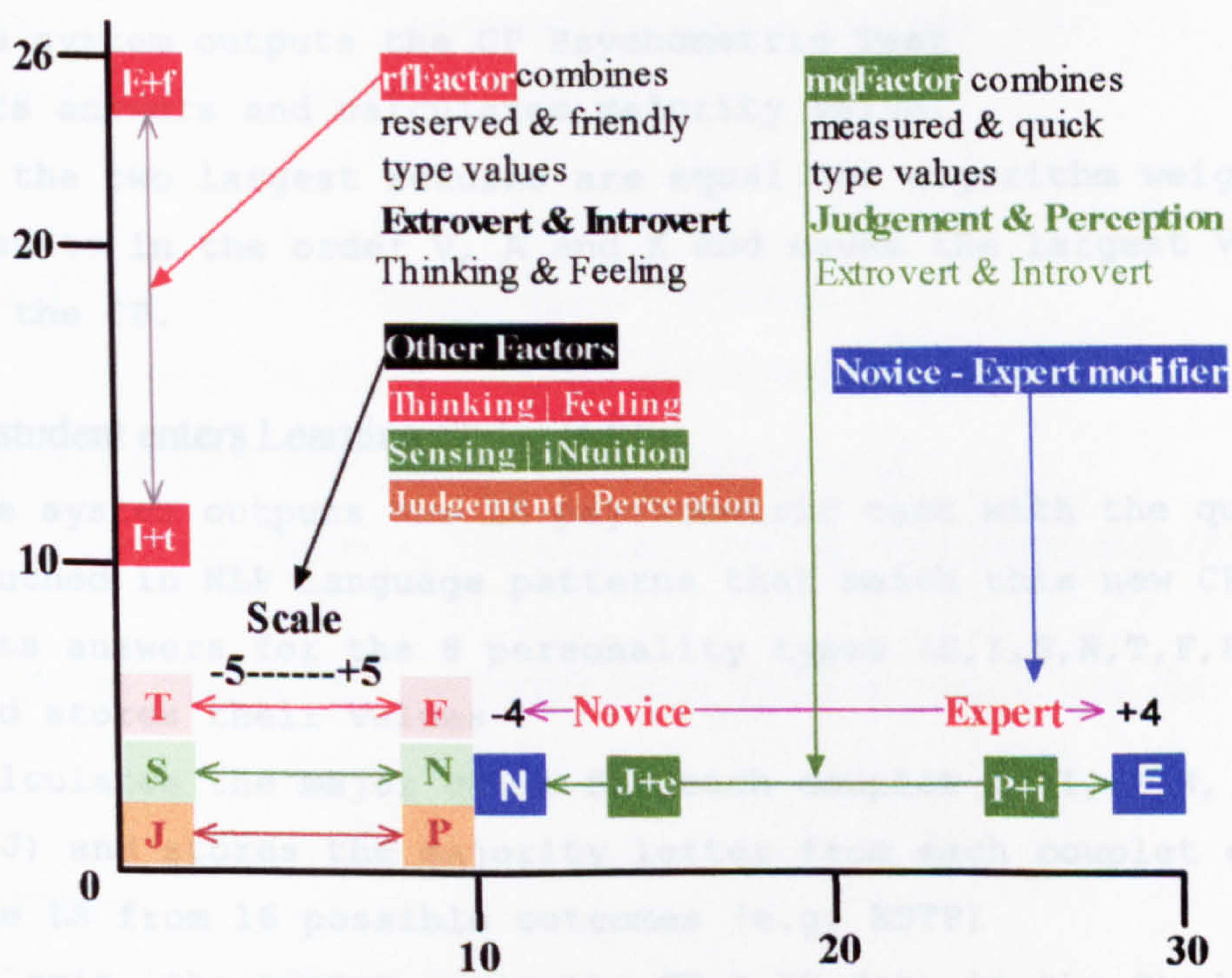


Figure 102 - Factor creation

Various factors are linked to the sixteen Learning Styles by algorithms, used in both Topic Learning and Topic Testing. The factor relationships are coded in both pages and cover measured | quick and reserved | friendly characteristics:

- **mqFactor** - The personality type of *Judgment* or *Perception* play a greater part with the *Extrovert* or *Introvert* types affecting this less as reflected by the algorithm (see Fig.102)
- **neFactor** - Built into the mqFactor is the Novice - Expert factor as per coding:
  `mqFactor = round(emq+imq+jmq+pmq+neFactor)`
- **rfFactor** - this combines reserved and friendly type values. Here *Extrovert* and *Introvert* personality values are major whilst *Thinking* and *Feeling* play a minor part: the other types do not affect this factor, as per coding
  `rfFactor = round (erf+irf+trf+frf).`
- **siFactor** - Sensing | iNtuition, **tfFactor** - Thinking | Feeling, **jpFactor** - Judgment | Perception and Extrovert | Introvert affect feedback. Here the header messages are implemented to take cognizance of these factors (see Pg.125 – Fig.56).

6.7.2.2 System Algorithm Outline

The following outlines the essence of the intuitive interactive section of the system.

When a student enters Communication Preference (CP)

- The system outputs the CP Psychometric Test
- Gets answers and calculates majority value.
- IF the two largest returns are equal the algorithm weights the results in the order V, A and K and saves the largest V, A or K as the CP.

When the student enters Learning Styles (LS)

- The system outputs the LS psychometric test with the questions couched in NLP language patterns that match this new CP.
- Gets answers for the 8 personality types (E,I,S,N,T,F,P and J) and stores their values
- Calculates the major value for each couplet (E|I, S|N, T|F, P|J) and stores the majority letter from each couplet creating the LS from 16 possible outcomes (e.g. ESTP)
- On exit, the system saves the CP & LS data in the Student Initial Profile table

When student enters Topic Learning (TL) or Topic Testing (TT) the system

- Gets and Stores input source
  (newUser entry, existingUserNewEntry or existingUserAnswer)

- Gets and Stores the studentProfileChange data (SPCD) if the student has opted to control output
- Gets and Stores the current module mark, CorrectAnswerButton mark (CAB) and module NEfactor - ranging from 0 to 8
- Gets and Stores the topic CAB mark and topic NEfactor - this last also ranges from 0 to 8

  OR if no data exists

      Gets and Stores the default entries for neFactors (=3), Topic CAB (=0), Module CAB (=0) and mark (=0).
- Gets and Stores the current rf, mq, si, tf and jp Factors
- Gets and Stores the CP value
- Calculates and Stores Topic Novice|Expert factor (NEfactor)

      NEfactor = current value or default if 1st question in topic

      For existingUserAnswer increments or decrements the Nefactor as relevant (+1 or -1)

      Tests the NEFactor parameters and resets to these if exceeded
- Gets and Stores CP and LS values
- Creates and Stores reserved|friendly factors (rf) and measured|quick factors (mq)

NOTES:

The **rfFactor** is NOT changed due to the values of:

Sensing, iNtuition, Judgment and Perception values

The **mqFactor** is NOT changed due to the values of:

Sensing, iNtuition, Thinking and Feeling, they cancel each other out.

The input stored data is then converted using the following values that reflect the design:

Feedback values:

Extrovert	(efb) = E value	Feelings	(ffb) = F value
Introvert	(ifb) = I value	Thinking	(tfb) = T value
Sensing	(sfb) = S value	Perception	(pfb) = P value
iNtuition	(nfb) = N value	Judgment	(jfb) = J value
rf Factors		**mq Factors**	
Extrovert	(erf) = 5+efb	Extrovert	(emq) = 5+(efb/5)
Introvert	(irf) = 5-ifb	Introvert	(imq) = 5-(ifb/5)
Thinking	(trf) = 5-(tfb/5)	Judgment	(jmq) = 5+jfb

```
Feelings    (frf) = 5+(ffb/5) Perception  (pmq) = 5-pfb
rfFactor          = round(erf+irf+trf+frf)
mqFactor          = round(emq+imq+jmq+pmq+topicNEfactor)
```

The system *Gets and Stores* into temporary memory:

- Current grade marks, module grade, topic grade
- Current question, image address, topicID, topic name
  - Calculates and stores current grade values as *a,b,c,d,e,f* and *pass* as relevant
- Relevant CP header messages
  - Calculates number of header messages
- Relevant end message
- Random question prefix
  - Verifies question-header message random number
  - Question prefix header-message
- Answer-header number random number
  - Answer prefix header-message
- rfFactor and mqFactor users-messages
- General feedback-messages
- Reward-messages
- Analysis Report button-messages
- Statistical-messages
  - Module/topic combined-messages
  - **OR**
  - Topic-messages and Module-messages

- The system's algorithms check if the student has opted for control and outputs the relevant messages and information

  OR
- Sets the adviceCount = a varying number controlled by the value of the rfFactor.

  PLUS
- Increments the adviceCount = + a varying number controlled by the mqFactor.
- Changes adviceCount to upper or lower parameters if exceeded

The system's algorithms then output the relevant information from the client-PC's temporary memory reflecting the stored factors and information. In the event that additional information is requested, such as the Statistical Report, the new page is quickly loaded from the temporarily stored data. Once again the system's algorithms in that particular page control this output.

6.7.2.3 Header Messages

Fig.103 shows an extract of the data held in the prefix table in *wisdemPed* database. This table provides all relevant NLP Language Pattern headers.

Type	Description
Msga	After you have read something, summarize it on tape and/or verbally review important parts aloud.
Msga	Associate knowledge with music and rehearse aloud your mnemonics.
Msga	Concentrate on listening to lectures, tape them and participate in discussions or discuss the lecture with a friend.
Msga	Learn by interviewing or by participating in discussions or debates.
Msga	Read the bibliographic references aloud and try playing some background music whilst you are studying.
Msga	Use tapes for reading and for class and lecture notes and verbally review lectures with a colleague.
msga1	This auditory rehearsal aids memory.
Msgk	If possible, stand up when working and listen to music you like whilst you study.
Msgk	Read the bibliographical references in detail, make notes and use bright colours to highlight important details.
Msgk	Skim read material to get a rough idea what it is about before settling down to read it in detail.
Msgk	Take frequent breaks in study period, play background music and use a computer to aid learning through a sense touch.
Msgk	Use a computer to reinforce learning through a sense of touch.
Msgk	Write out facts several times and repeat them whilst walking/exercising.
msgk1	Use tactile/feeling rehearsal to remember and recall facts.
Msgv	At lectures, look at your tutor's body language/facial expressions, take notes and go over handouts.
Msgv	Illustrate your ideas as a picture before writing them down.
Msgv	Sketch ideas; use multi-media and study in a quiet place away from noise.
Msgv	Use colour to highlight important points in text and use brainstorming bubbles to illustrate facts you want to remember.
Msgv	Use visual materials such as pictures, charts, maps and graphs, etc.
Msgv	Visualize facts to be memorized and write out everything for quick and frequent visual review.
msgv1	Visual rehearsal will help you to remember and recall information.

Figure 103 - Header Messages

a=auditory, k=kinaesthetic, v=visual and the postfix 1 indicates that this message is output every time.

As stated above, the number of header message lines is governed by both the rfFactor and the mqFactor as per the following:

```
'get number of messages
      adviceCount=0
      IF rfFactor<17 THEN
         adviceCount=2
      ELSEIF rfFactor>16 AND rfFactor<21 THEN
         adviceCount=1
      ELSE
         adviceCount=0
      END IF

      IF mqFactor<14 THEN
         adviceCount=adviceCount+3
      ELSEIF mqFactor>13 AND mqFactor<18 THEN
         adviceCount=adviceCount+1
      ELSEIF mqFactor>17 AND mqFactor<22 THEN
         adviceCount=adviceCount+1
      ELSEIF mqFactor>25 THEN
         adviceCount=99
      END IF
```

Thus the number of advice lines can vary from 0 to 5 with the final line always being output (see msgv1, msga1 and msgk1).

The NLP Language Pattern headers for both the question and the three answers are randomized from the prefix table from a choice of five per CP type (VAK), thus over a period of time the student will see the same prefix and ignore conscious attention to the message; however, subliminal text messaging input is likely to take place and still influence the way that the questions and answers are processed.

The coding also allows the student to select any week/topic to revise; however, as implemented at this time he/she does not have the facility to choose a specific start point within a topic. Each question has been linked to its bibliographical source using the table *RTbibliography* in *wisdemPed* database and to *RTbiblioDetail* for links to relevant slides and images.

Thus the page has been implemented to provide the student with output matching his/her CPLS, answers with feedback and links to additional pedagogical information, all designed to enhance rehearsal and memory retention and recall.

6.7.2.4 *Topic Testing*

The section is implemented to interact with the student using his/her CPLS and novice / expert development, provide textual rewards and stimuli.

The student enters the *'Revision Select'* page, as with Topic Learning; however, this time he/she selects Topic Testing and is directed through *'inputDataSelect.asp'*. This checks if his/her ID exits in the *'studentLastEntry'* table in *wisdemAI*.

This table stores the last entry for any student who has used the system (see Fig.140). These coordinates hold information for the system to re-open Topics Learning exactly where the student was when he/she left the system.

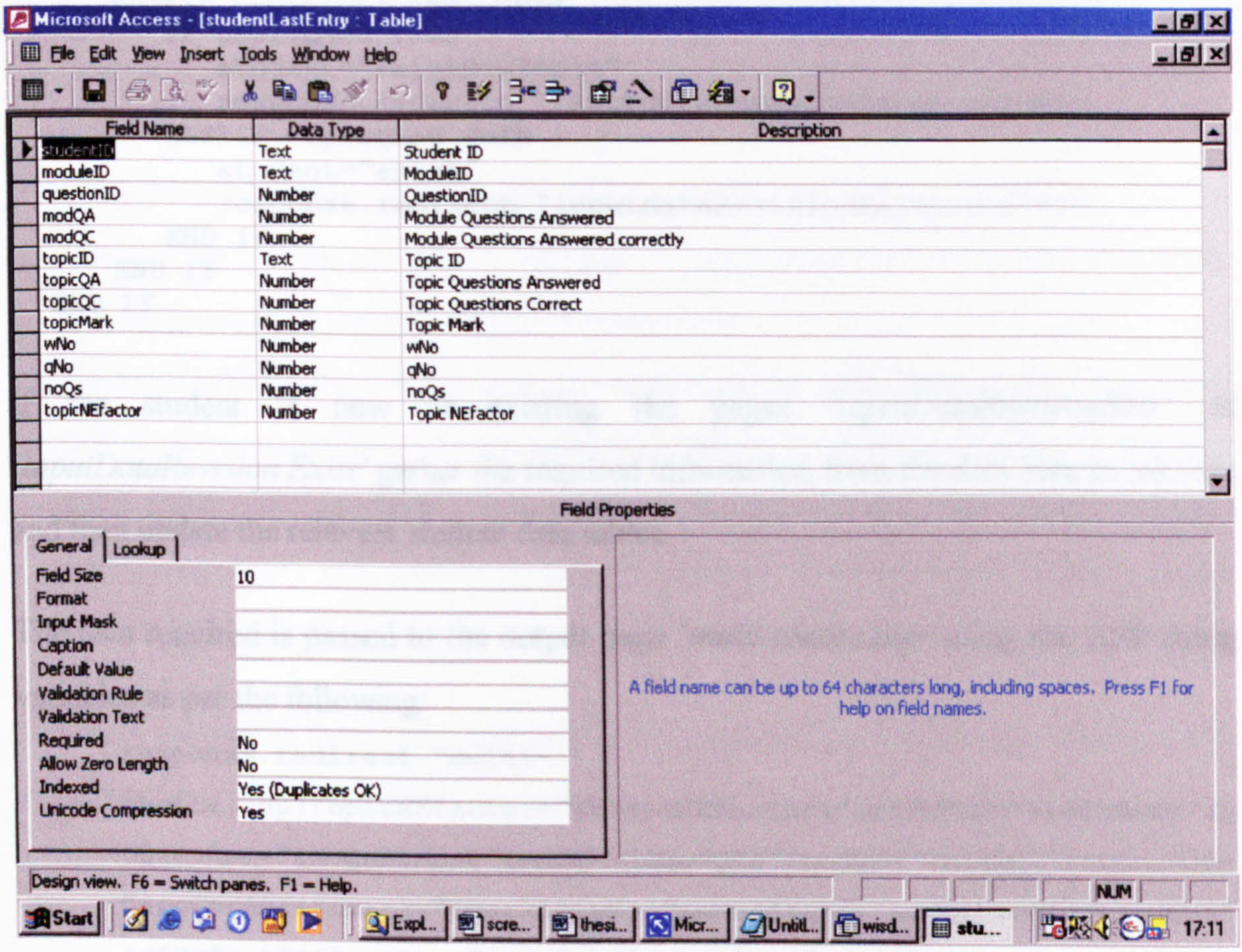


Figure 104 – studentLastEntry data table in wisdemAI

The system then checks to see how many entries exist in the *'studentActiveTopicProfile'* table in *wisdemAI* (a line exists in this table for all completed topics or a partially completed topic, there can only be one of the latter) and then redirects the student as per the following algorithm with the relevant data carried by session and page variables:

```
IF lineCount=0 THEN
   student="new"
   response.redirect "inputdataRevisionNew.asp?etc
ELSEIF lineCount=1 THEN
   IF topicID="new" THEN
      student="new"
      response.redirect "inputdataRevisionNew.asp?etc
   ELSEIF topicID<>"new" THEN
      IF topicQA=0 THEN
         student="existNew"
         response.redirect "inputdataRevisionExist.asp?etc
      ELSEIF topicQA>0 THEN
         student="exist"
         response.redirect "inputdataRevisionExist.asp?etc
      END IF
   END IF
ELSEIF lineCount>1 THEN
   IF topicID="new" THEN
      student="newTopic"
      response.redirect "inputdataRevisionExist.asp?etc
   ELSEIF topicID<>"new" THEN
      IF topicQA=0 THEN
         student="existNewTopic"
         response.redirect "inputdataRevisionExist.asp?etc
      ELSEIF topicQA>0 THEN
         student="exist"
         response.redirect "inputdataRevisionExist.asp?etc
      END IF
   END IF
END IF
```

If the student is new or existing the pages *'inputDataRevisionNew'* or *'inputDataRevision Exist'* gather the required information from the data files as relevant and then update the relevant student data tables.

The data required is passed to the output page *'multi-choice.asp'* using the ASP string variables as per the following:

```
response.redirect "multi-
choice.asp?topicNEfactor="&topicNEfactor&"&rtFbNum="&rtFbNum&"&n
oQuesAns="&noQuesAns&"&modQA="&modQA&"&modQC="&modQC&"&noCorAns=
"&noCorAns&"&mark="&mark&"&wNo="&wNo&"&qNo="&qNo&"&noQs="&noQs&"
&qID="&qID&"&corAns="&corAns&"&quesAns="&quesAns
```

The system now processes the information as shown by the DND Dialogue Diagrams (see Pg.86 - Fig.32) and (Pg.88 - Fig.33).

Anytime the student leaves 'multi-choice.asp', except by switching off or leaving the system dormant until the session time has expired, the student profile is updated (see Pg.89 - Fig.34).

The student's data is held in a number of tables:

- *StudentActiveModuleProfile* – this table holds a total of ALL topic entries required to keep track of the student's current state.
- *StudentActiveModuleProfileBkUp* – this table holds a line for each student for the student's module state at the time he/she uses the restart topic or module button. This allows the tutor to track student performance.
- *StudentActiveTopicProfile* – this table holds a total of the CURRENT topic entries required to keep track of the student's current state for this topic.
- *StudentActiveTopicProfileBkUp* – this table holds a line for each student for the student's topic state at the time he/she uses the restart topic or module button. This allows the tutor to track student performance.
- *StudentData* – this holds a list of the status of all questions answered by the student (Ids for student, module, topic, question and whether the answers was correct or not).
- *StudentLastEntry* (see Pg.175 - Fig.104).
- *StudentProfile* – this table holds the original CPLS data (studentID, schoolID, cp, ls, and the numbers recorded for each learning style).
- *StudentProfileChange* – this hold the data required enabling a student to change output screen to his/her own preferences by using the 'Change Feedback Response' page (studentID, moduleID, the existing CP, the new CP, the state of original header messages and feedback, and the state of the new header messages and feedback fields).

The data carried in each of these tables is dynamically changed as required: this maintains the student's profile at all times.

See the following DNDs explicit description from which the design, coding, functionality and output was created:

- Pg.86 - Fig.32 - DND - Level 0 - Revision Multi-choice Q&A flow chart
- Pg.88 - Fig.33 - DND - Level 1 - Revision Multi-choice Q&A flow chart
- Pg.89 - Fig.34 - DND - Level 1 - Student Profile flow-chart
- Pg.90 - Fig.35 - DND - Level 2 - Q&A - Show correct Answer flow chart
- Pg.91 - Fig.36 - DND - Level 2 - Q&A - Selected Answers flow chart
- Pg.92 - Fig.37 - DND - Level 2 - Q&A - Analysis report flow chart

The following WISDeM Screen Shots show the output for the Topic Testing screen when the question is asked (Fig.105 & Fig.106 for output):

- The module gross running total is updated by the system and shows the percentage score of all questions correctly answered / all questions attempted. It does not show the reduced CAB result produced in the statistical report. This latter is produced by decrementing the correct answer score by the number of times the CAB button has been used.
- The RED header message is output for every student. The content and number of lines is dynamically produced by the system taking into account the changing Student Profile status for Learning Styles factors and Novice|Expert factor. Where the profile indicates a student who requires little feedback, the system algorithms only output the BLUE line. Even this can be removed if the student requests NO header message output. Here the algorithms store the current updated profile but suppresses reporting as requested.

  The system algorithms select the GREEN header messages for the question and each answer randomly from the database. These are couched in the student's CP style established when the student completed the psychometric test. The student has the ability to change this output to visual, auditory, kinaesthetic or none. The 'change header message' facility allows this. Thus the algorithms first check if such a request has been made and act accordingly. The bank of header messages is limited and over a period of time the student will see the same header, and, as previously covered, consciously ignore it but subliminally note it.

The following WISDeM Screen Shots show the output for the Topic Testing screen when feedback is given:

- Pg.180 - Fig.107 - Revision Topic Testing Feedback Pt1 for output

  The gross running total is change to reflect the student's answer

  Correct or **Incorrect** is displayed to let the student know the result of his/her choice.

  The header message changes and provides motivational feedback generated by the system's algorithms. The output is governed by the factors created from the student's LS and NE (see Pg.167 – Fig.100), and by the student's CP.

- Pg.181 - Fig.108 - Revision Topic Testing Feedback Pt2 for output.

The correct answer has the header message output in blue. Once again the system's algorithms selected random messages randomly from a bank of messages pertinent to the student's CP. If the student's profile requires every answer will have feedback showing, this usually applies to an introvert personality type with a low correct answer score. If the algorithms detect poor results the student will be advised to restart the Topic Testing, or indeed Module Testing, revisit Topic Learning and start again.

The blue hyperlinks allow the student to control output (Pg.129 - Fig.60 & Fig.61 - Change Feedback Response), read all the header messages applicable to his/her LS rather than those selected by the system's algorithms (header messages - see Pg.191 & 192 - Fig.118 & Fig.119), view all the feedback for the current bank of answers (see Pg.192 - Fig.120), and get a statistical report (see Pg.193 - Fig.121).

In addition he/she has the facilities that the buttons offer (see Pg.182 - Buttons and Hyperlinks in Multi-choice Q&A).

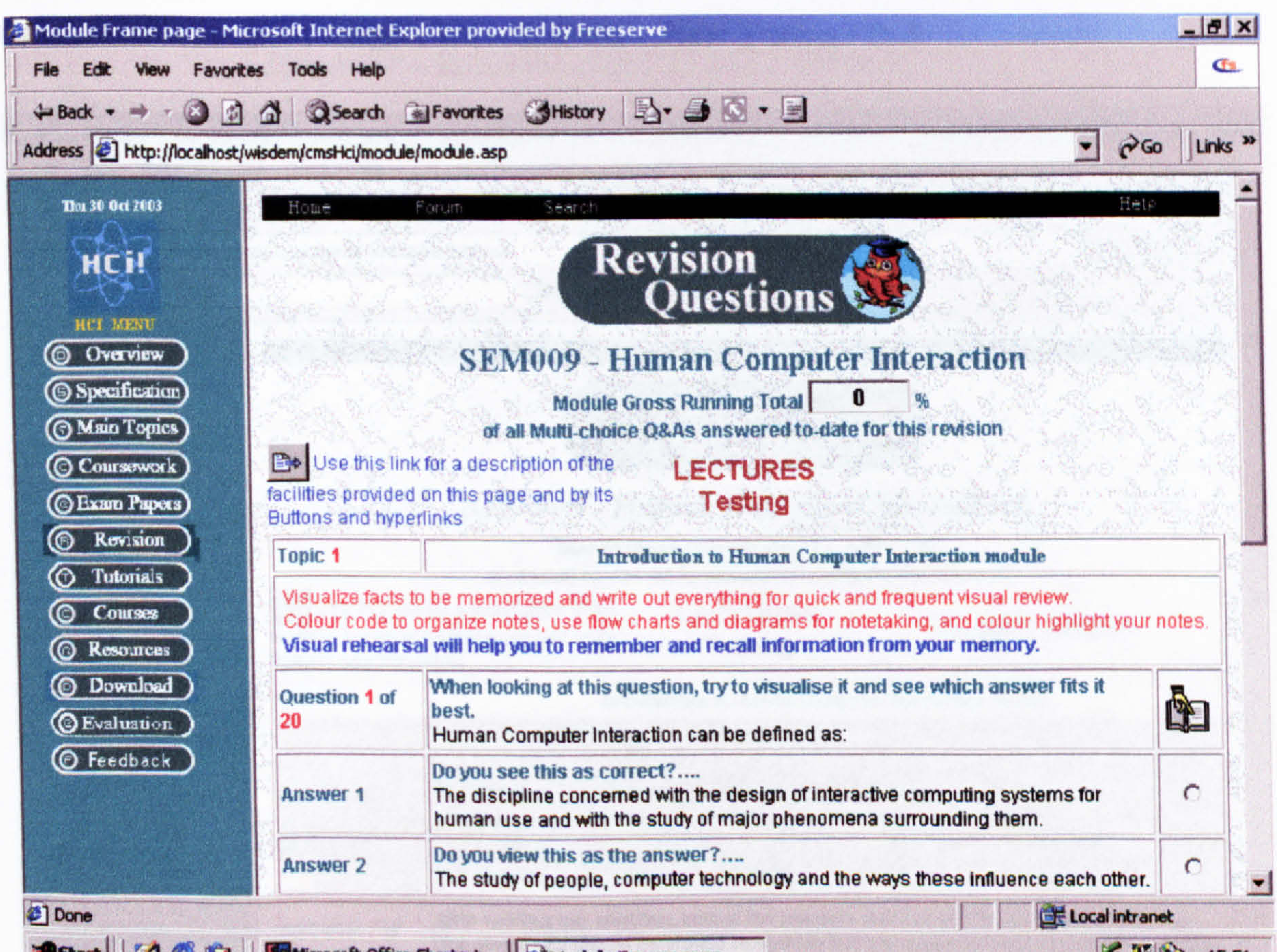


Figure 105 – Topic Testing Pt1 showing header message

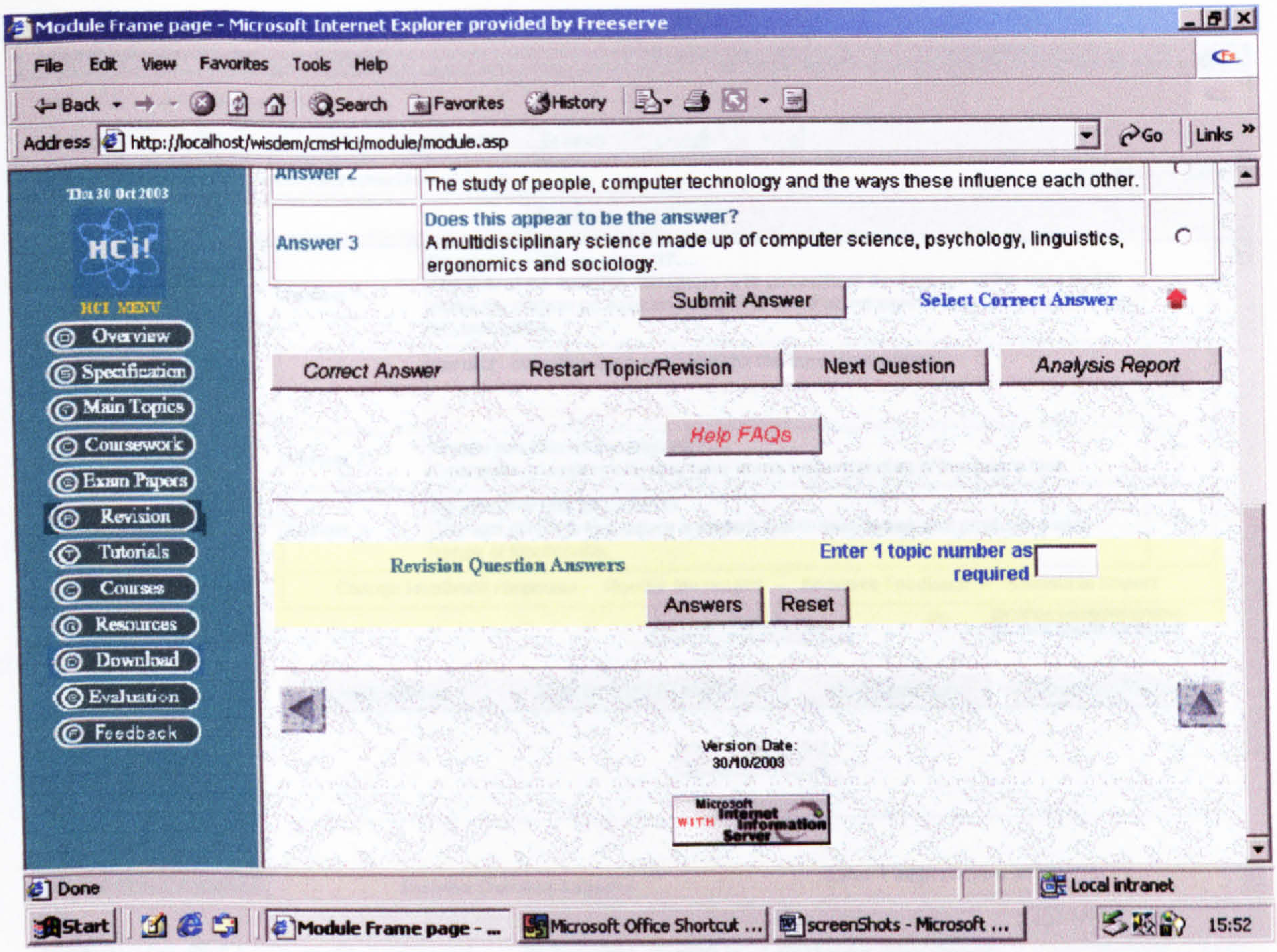


Figure 106 – Revision – Topic Testing – Pt 2

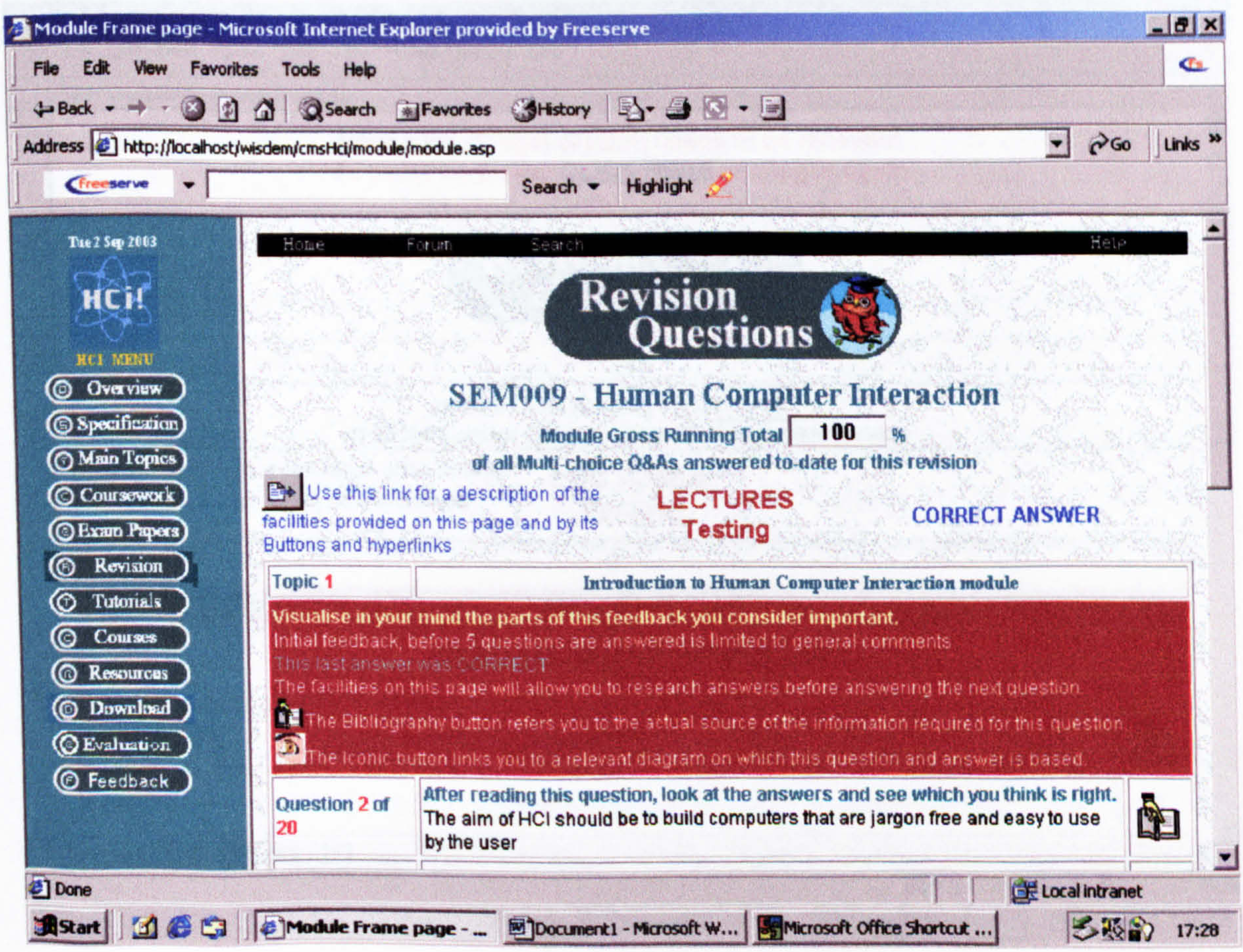


Figure 107 – Revision – Topic Testing – Feedback – Pt1

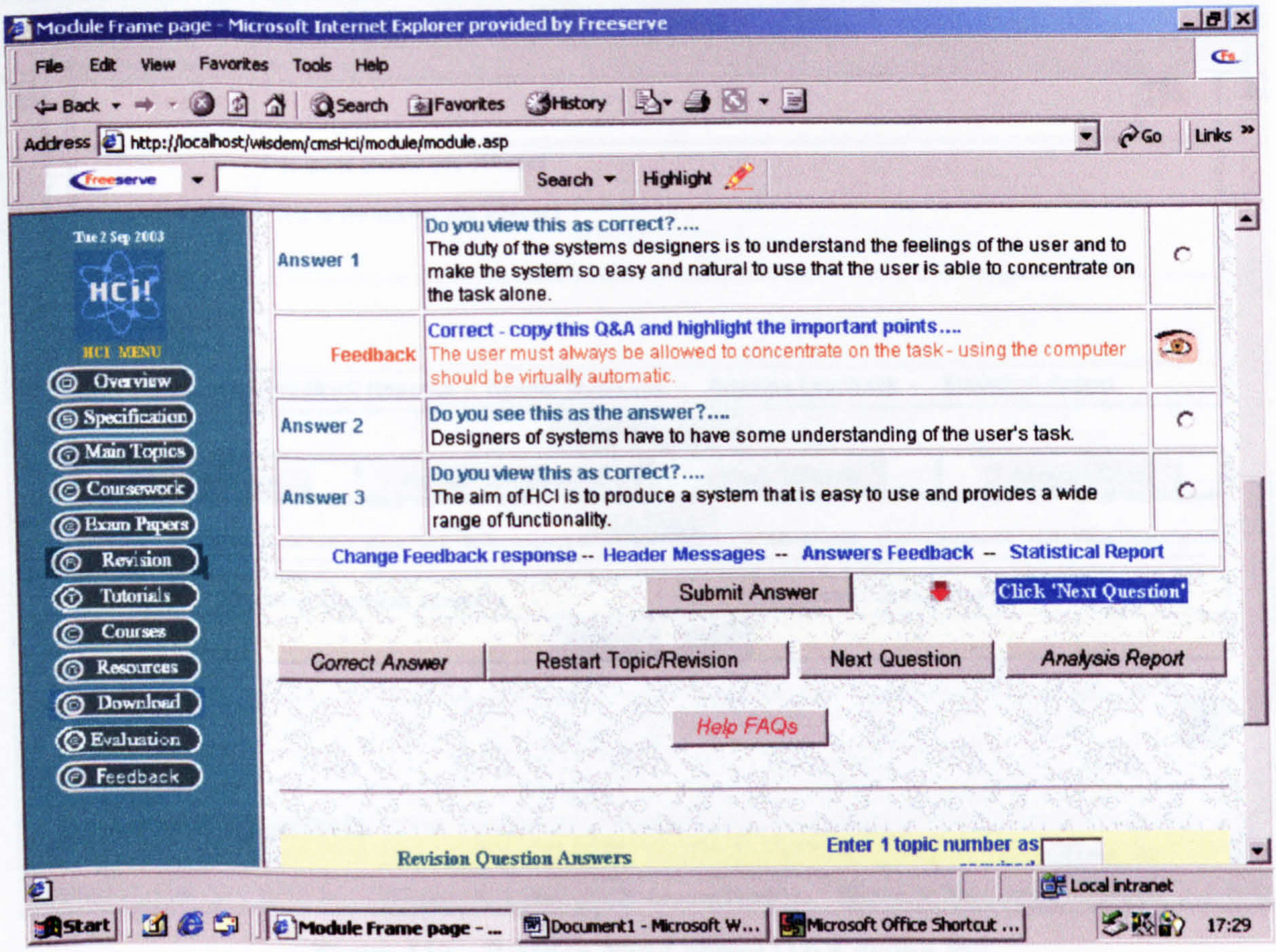


Figure 108 – Revision – Topic Testing – Feedback – Pt2.

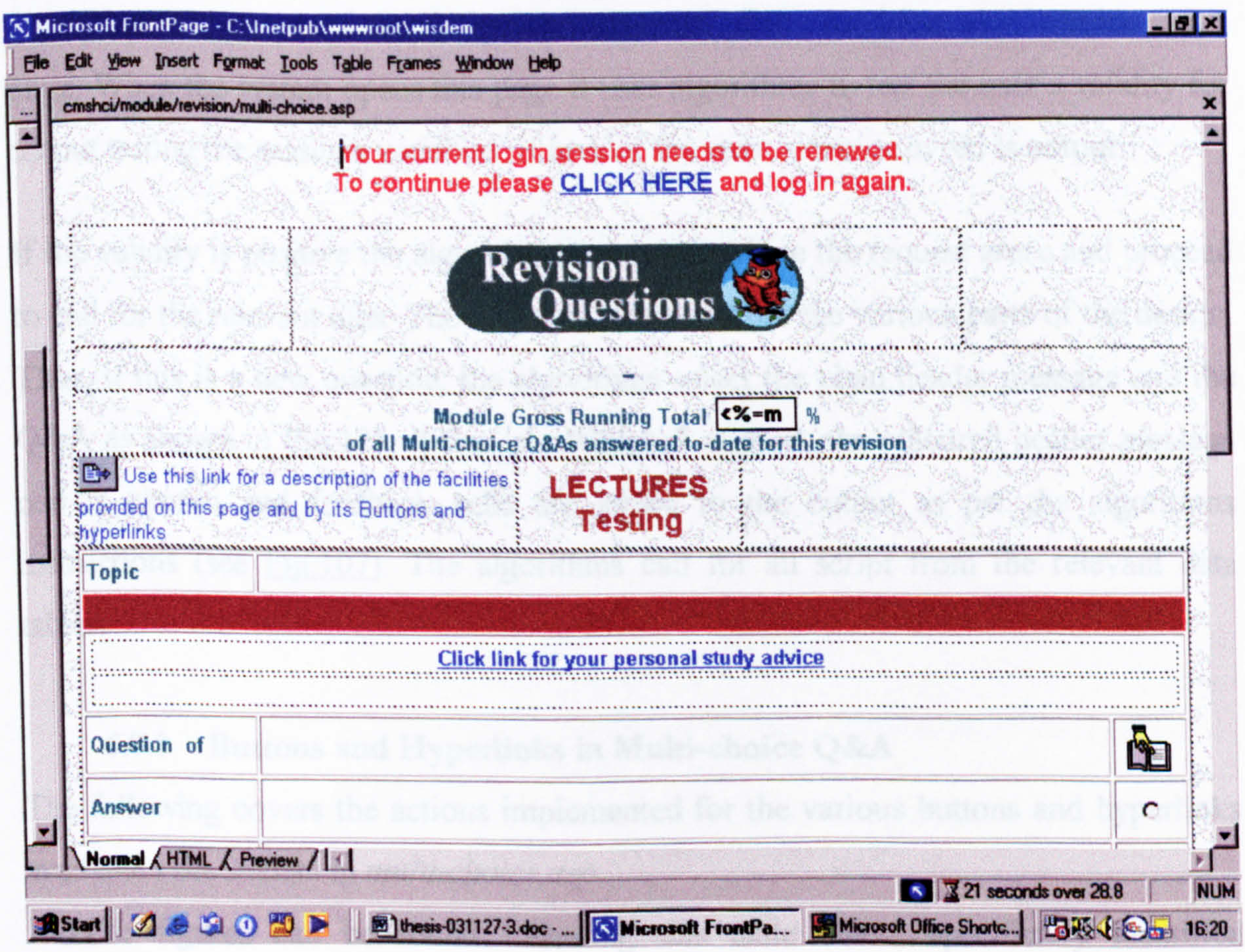


Figure 109 – Revision Multi-choice Q&A design – Pt1

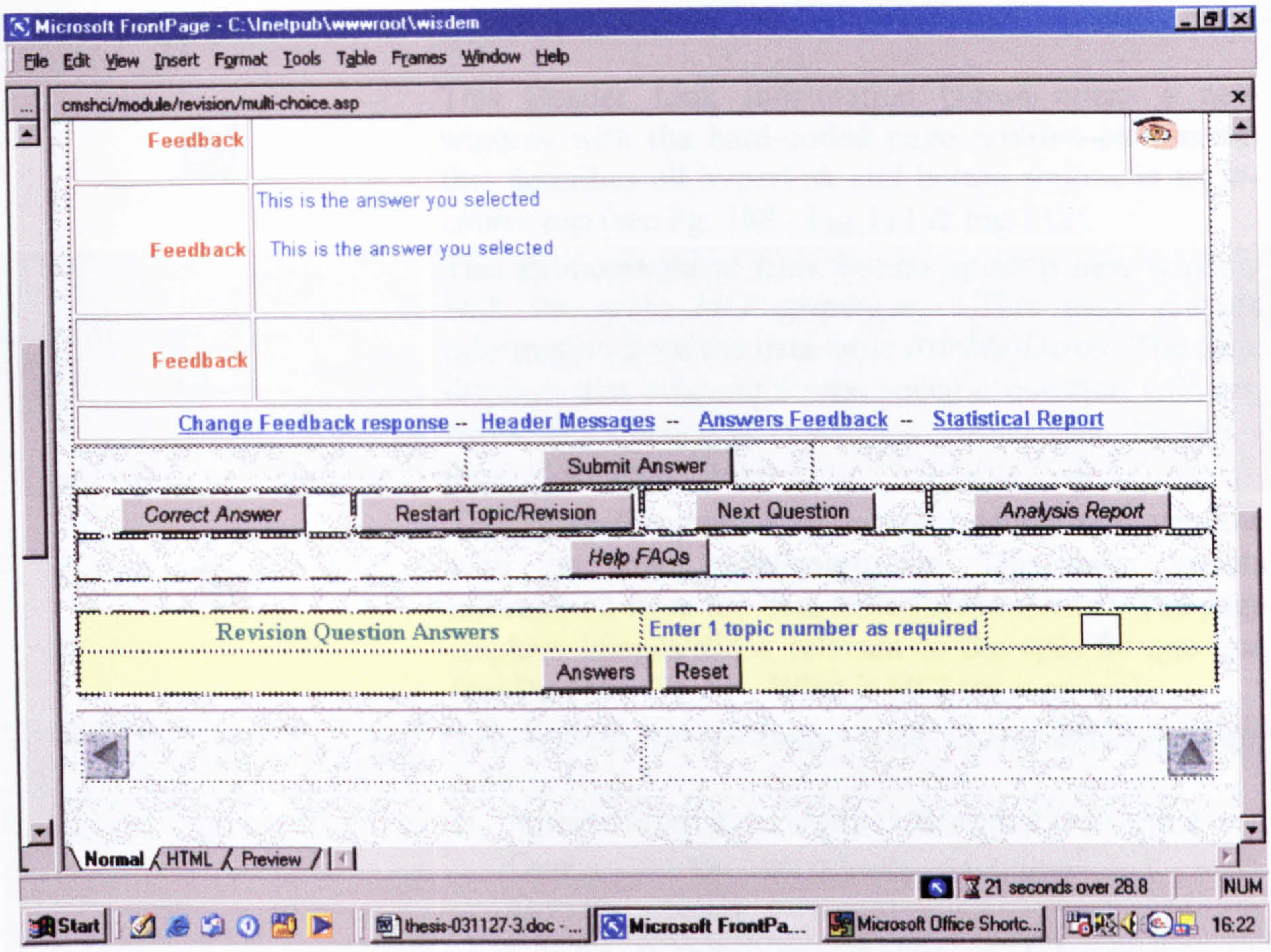


Figure 110 – Revision Multi-choice Q&A design Pt2

Fig.109 & Fig.110 show the design and structure of the Revision Multi-choice Q&A page. When the system opens this page it uses algorithms to test the user's validity for output testing the sessions variables: if invalid the error message in red is output.

If the validity is positive the algorithms test to see where the request arose and proceed to call for the relevant data. The output is selected from the various parts of the design. Thus, if this is a new question, the algorithms select the plain header message and the Q&A as shown in Fig.105, if this is a feedback request, the coloured header message cell is chosen and feedback cells are added to the output as per the algorithms instructions (see Fig.107). The algorithms call for all script from the relevant data tables.

6.7.3 Buttons and Hyperlinks in Multi-choice Q&A

The following covers the actions implemented for the various buttons and hyperlinks available t the student in *multi-choice.asp*:

NOTE: figures can be found following this table unless specifically identified elsewhere.

Button	Description
	This Header Link Information button opens a new window with the hard-coded page *revision-buttons.asp* that describes all hyperlink and button actions in *multi-choice.asp* (see Pg. 188 - Fig.111 & Fig.112).
	This Bibliographical Link button opens a new window with the page *bibliography.asp*. This page outputs information from the data table *RtbiblioDetail*. The page displays data relevant to the specific question - Slides, hyperlink, Diagram, Book and Pages (see Pg.189 - Fig.113 for example)
	This Image/Diagram Link button opens a new window with the page *pedalImages.asp*. This page outputs information from the data table *RtbiblioDetail*. The page displays images/slides relevant to the specific question (see Pg.116 - Fig.51 - What is HCI for example).
Submit Answer	This Submit Answer button uses '*inputDataAnswer.asp*' which: ❑ Stores the input variables in temporary variables ❑ Opens database connectivity as required ❑ Gets the topicID ❑ Checks if question answered and establishes the AnswerID ❑ If the question not already answered store data in studentData tables ❑ Increments correct answer and question count, and mark as relevant ❑ Checks if the student has used the Correct Answer Button (*studentCABflag* status) ❑ Calculate new percentile mark ❑ Update *studentActiveTopicProfile* table ❑ Gets the number of topic questions answered and answered correctly ❑ Updates *SudentActiveTopicProfile* and *StudentActiveModuleProfile* ❑ Removes CAB the flag ❑ Stores data in the *studentLastEntry* data table ❑ IF weekNumber >12 THEN redirects to "*multi-choice-end.asp*" ❑ IF number of new questions = 0 THEN redirects to "*noQuestion.asp*" - ELSE redirects to "*multi-choice.asp*" with the required data to continue.
Correct Answer	This Correct Answer button opens a new small window with a black background - '*correctAnswer.asp*' which: ❑ Opens database connectivity ❑ Checks source ❑ IF source="revision" THEN o checks if entry in *studentData* table o gets *RTanswer* data

- o checks if studentCABflag exists for this entry
  - enter studentCABflag
- o updates CAB count in *studentActiveModule / TopicProfile* (SAMP & SATP)
- o stores existing data from *SAMP*
- o stores existing data from *SATP*
- o increments modHcnt and topicHcnt
- o updates *SAMP* datafiles
- o updates *SATP* datafiles

❑ ELSEIF source="course" THEN

- o checks if entry in *studentCourseData*
- o gets *RTanswer* data
- o updates *studentCourseMarks*

(See Pg.189 - Fig.114 - Correct Answer Button output)

Restart Topic/Revision

This Restart Topic/Revision button links to the page '*restart.asp*' which allows the student to choose between:

1. Restart Topic
   This opens '*inputDataRestartTopic.asp*' which deletes the data from all relevant tables for all posted answers for this topic, resets '*studentLastEntry*' and return him/her to Question 1 of the current topic.
2. Restart Revision
   This opens '*inputDataRestartModule*' which deletes the data from ALL posted data for ALL topics, resets '*studentLastEntry*' and return him/her to Topic 1 - Question 1 - Mark 0.

The current data held in both '*studentActiveModuleProfile*' and '*studentActiveTopicProfile*' are saved in their relevant backup files. These record: studentID, moduleID, module | topic questions answered, module | topic questions answered correctly, module | topic CAB count, module | topic mark, module | topic NE factor and module | topic Entry Date &Time as relevant (see Pg.127 - Fig.59 - Revision Restart Topic or Revision facility).

Next Question

The Next Question button links to the hidden page *inputDataNextQ.asp* which:

- ❑ Stores temporary variables
- ❑ Opens database connectivity as required
- ❑ IF existing entry found *returns* with error message
- ❑ ELSEIF existing entry not found
  - o gets new question ID
  - o IF no new questions found
    - ▪ Redirects to *multi-choice-end*
  - o ELSE
    - ▪ IF topic changes

	▪ gets number of topic questions in use o Updates student tables as relevant o Redirects to *multi-choice* with required data
Analysis Report	The Analysis Report button opens a new window for *analysis.asp*. This page (see Fig.115 - Analysis Report) and outputs all required data from the student data tables. This includes a report for the total module data and a report for every topic fully or partially completed. The page is implemented with a link for every answer to *answers.asp* (see Answers button).
Help FAQs	The Help FAQs button opens a new window for the *help.asp* file held in help/revisionTutorial. This help file, where data is held in the '*wisdemPed - RThelp*' data table, is specific for both the Revision and Tutorial facilities and is not linked to module help where data is held in the '*cmshci - help*' data table (see Pg.124 - Fig.54 - Help Page for selection page). Initially it is implemented to produce a list of all contents in title order (help_ID, title, description fields) and on selection automatically opens '*help_description.asp*' (see Pg.190 - Fig.116 - Help 'Header Feedback' information). *NOTE*: Help output is colour coded: Module help uses a yellow page background, Revision/Tutorial help uses a green background
Answers	This facility is designed to enhance memory rehearsal and thereby memory retention and recall. The student is required to enter a topic number in the box and click the Answers button. The Answers button opens a **new window** for the *answers.asp* file (see Pg.191 - Fig.117 - Revision Question and Answer facility). The student selects which question he/she wishes to see the answer for and sees a further **new window:** this allows the student to make multiple searches. Each window only shows the answer - it is implemented **NOT** to show which answer is relevant, this requires the student to compare answers thereby encouraging rehearsal (see Fig.122 - Question with Correct Answer).

<table>
<tr><th>Hyperlinks</th><th>Description</th></tr>
<tr><td>Change Feedback Response</td><td>The hyperlink opens a new window for the changeFeedbackResponse.asp file (see Pg.129 - Fig.60 & Fig.61 - Change Feedback Response): these diagrams show all the options provided for the student.

This page is implemented to
❑ Create temporary variables from input
❑ Open database connectivity as relevant
❑ IF student held in studentProfileChange data table
    o Store data in temporary variables
❑ ELSE
    o Create default temporary variables
    o Store Current Header Messages, Original Header Messages, Current Answer Feedback and Original Answer Feedback status
❑ Get change Feedback input from screen
❑ Send required data to 'changeFBinput.asp'

'changeFBinput.asp' is a hidden page that saves the required data to 'studentProfileChange' data table and returns the Student to the current window - this outputs the changed status. 'studentProfileChange' also stores the original settings.</td></tr>
<tr><td>Header Messages</td><td>The hyperlink opens a new window for the 'reportHeaderMessages.asp' file (see Pg.191 & 192 - Fig.118 and Fig.119 - Header Messages). This page is implemented to store ALL data from the data tables relevant to the Header Message output in temporary variables on the client browser. From these relevant parts are selected for output governed by the student's profile either original or as changed by the student:
❑ Store input data
❑ Open connectivity to relevant databases
❑ Get Communication Preference
❑ IF data held for student in studentProfileChange data table
    o Store data
❑ ELSE
    o Get user VAK
❑ Get relevant messages and end message
❑ Get flag messages (required for some introvert personality types)
❑ Get General Messages
❑ Get factor messages (e|i-s|n-f|t-j|p) as relevant

START get and progress information as relevant
❑ IF module Grade mark = topic Grade mark
    o Get joint progress information</td></tr>
</table>

	❑ ELSE
	  ○ Get individual progress information
	  ○ Get module report
	  ○ Get topic report
	❑ Output relevant reports

Answers Feedback	The hyperlink opens a new window for the '*reportAnswerFeedback.asp*' file (see Pg.192 - Fig.120). Whilst students can switch off any answer feedback using the '*Change Feedback Response*' button, most student profiles only show feedback for the selected answer. This page is implemented to output the current question, its answers and feedback using relevant NLP Language Pattern text for each prefix.
	❑ Store input data
	❑ Open database connectivity as required
	❑ Output Question prefix and Question
	❑ START loop for answers
	  ○ Output Answer prefix and Answer
	  ○ Output Feedback prefix and Feedback

Statistical Report	The hyperlink opens a new window for the '*reportStatistical.asp*' file (see Pg.193 - Fig.121). ❑ Store input data ❑ Open database connectivity as relevant ❑ Get statistical messages ❑ Output student's relevant statistical module messages and data ❑ Output student's statistical data and messages for each topic used

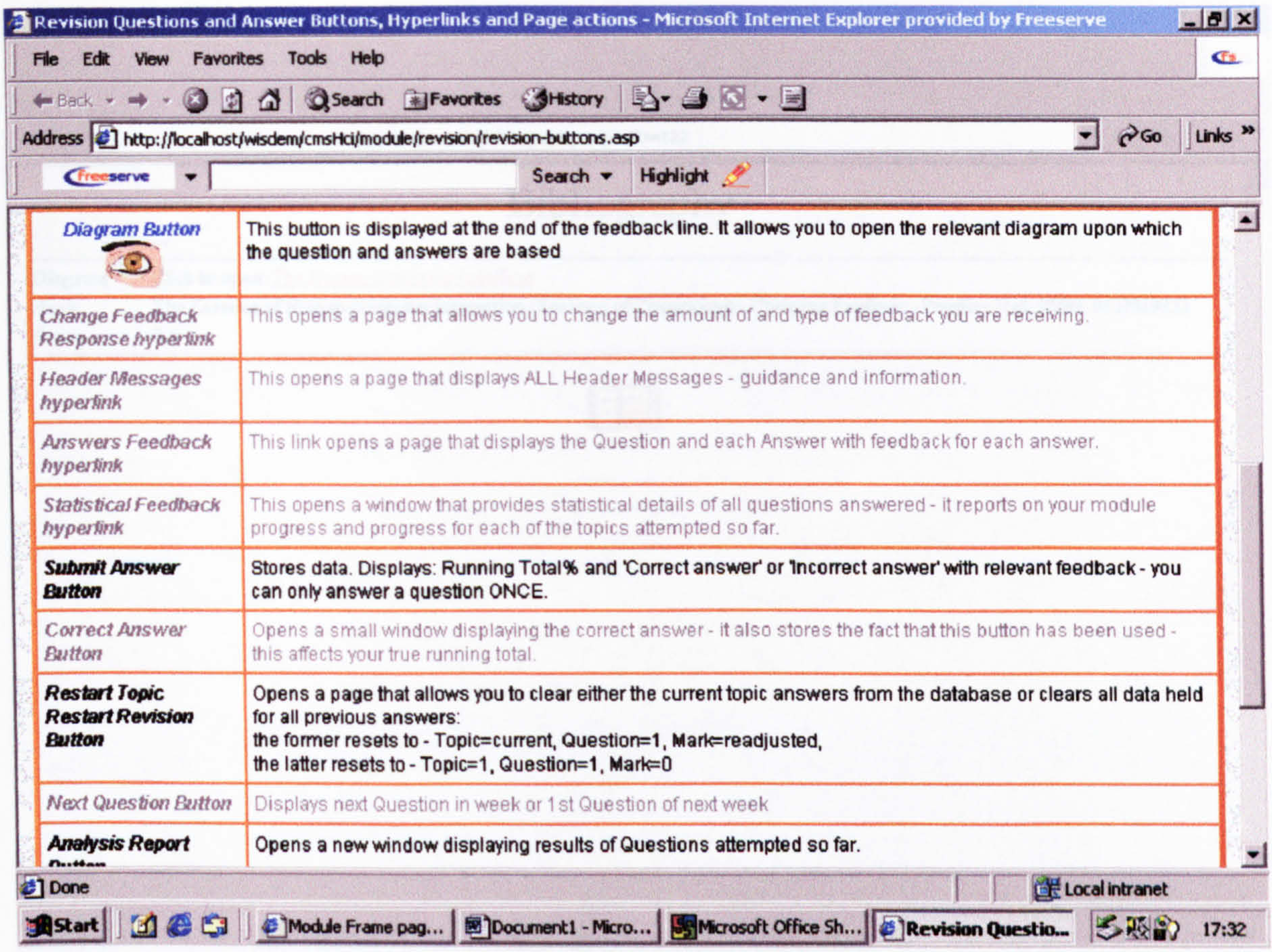
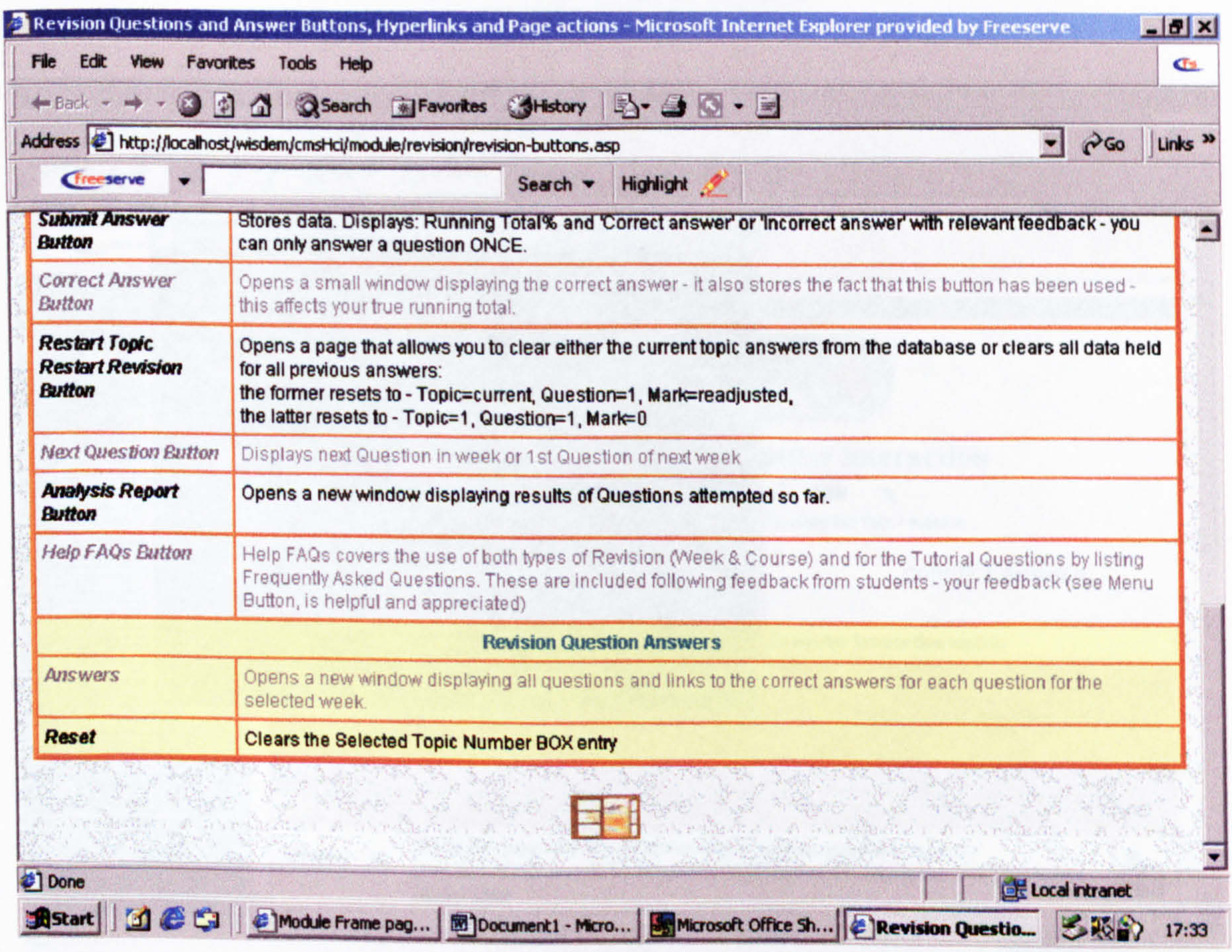


Diagram Button	This button is displayed at the end of the feedback line. It allows you to open the relevant diagram upon which the question and answers are based
Change Feedback Response hyperlink	This opens a page that allows you to change the amount of and type of feedback you are receiving.
Header Messages hyperlink	This opens a page that displays ALL Header Messages - guidance and information.
Answers Feedback hyperlink	This link opens a page that displays the Question and each Answer with feedback for each answer.
Statistical Feedback hyperlink	This opens a window that provides statistical details of all questions answered - it reports on your module progress and progress for each of the topics attempted so far.
Submit Answer Button	Stores data. Displays: Running Total% and 'Correct answer' or 'Incorrect answer' with relevant feedback - you can only answer a question ONCE.
Correct Answer Button	Opens a small window displaying the correct answer - it also stores the fact that this button has been used - this affects your true running total.
Restart Topic Restart Revision Button	Opens a page that allows you to clear either the current topic answers from the database or clears all data held for all previous answers: the former resets to - Topic=current, Question=1, Mark=readjusted, the latter resets to - Topic=1, Question=1, Mark=0
Next Question Button	Displays next Question in week or 1st Question of next week
Analysis Report Button	Opens a new window displaying results of Questions attempted so far.

Figure 111 - Header Link Button information - Pt.1



Submit Answer Button	Stores data. Displays: Running Total% and 'Correct answer' or 'Incorrect answer' with relevant feedback - you can only answer a question ONCE.
Correct Answer Button	Opens a small window displaying the correct answer - it also stores the fact that this button has been used - this affects your true running total.
Restart Topic Restart Revision Button	Opens a page that allows you to clear either the current topic answers from the database or clears all data held for all previous answers: the former resets to - Topic=current, Question=1, Mark=readjusted, the latter resets to - Topic=1, Question=1, Mark=0
Next Question Button	Displays next Question in week or 1st Question of next week
Analysis Report Button	Opens a new window displaying results of Questions attempted so far.
Help FAQs Button	Help FAQs covers the use of both types of Revision (Week & Course) and for the Tutorial Questions by listing Frequently Asked Questions. These are included following feedback from students - your feedback (see Menu Button, is helpful and appreciated)
Revision Question Answers	
Answers	Opens a new window displaying all questions and links to the correct answers for each question for the selected week.
Reset	Clears the Selected Topic Number BOX entry

Figure 112 - Header Link Button information - Pt.2

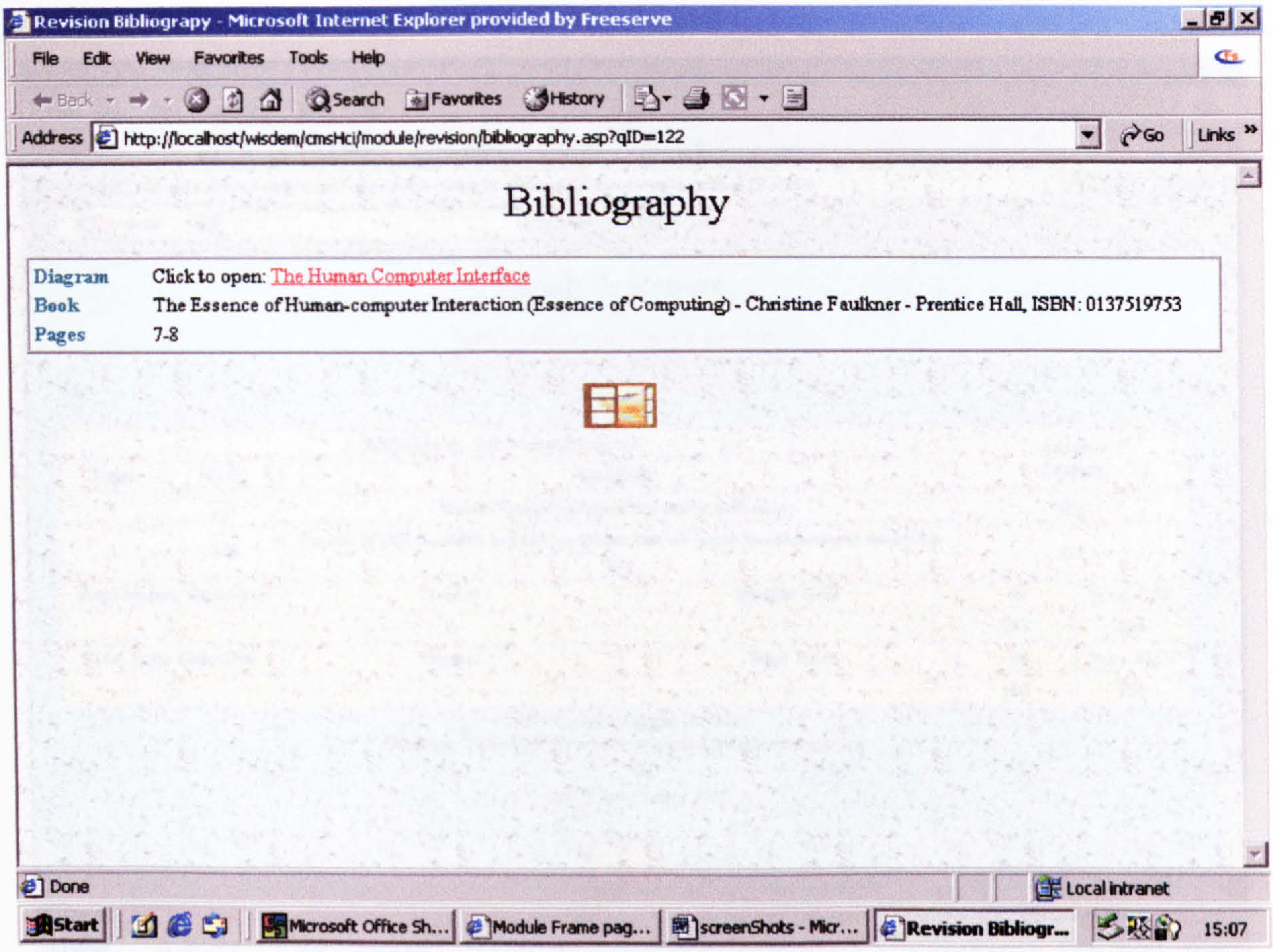


Figure 113 - Bibliographical page

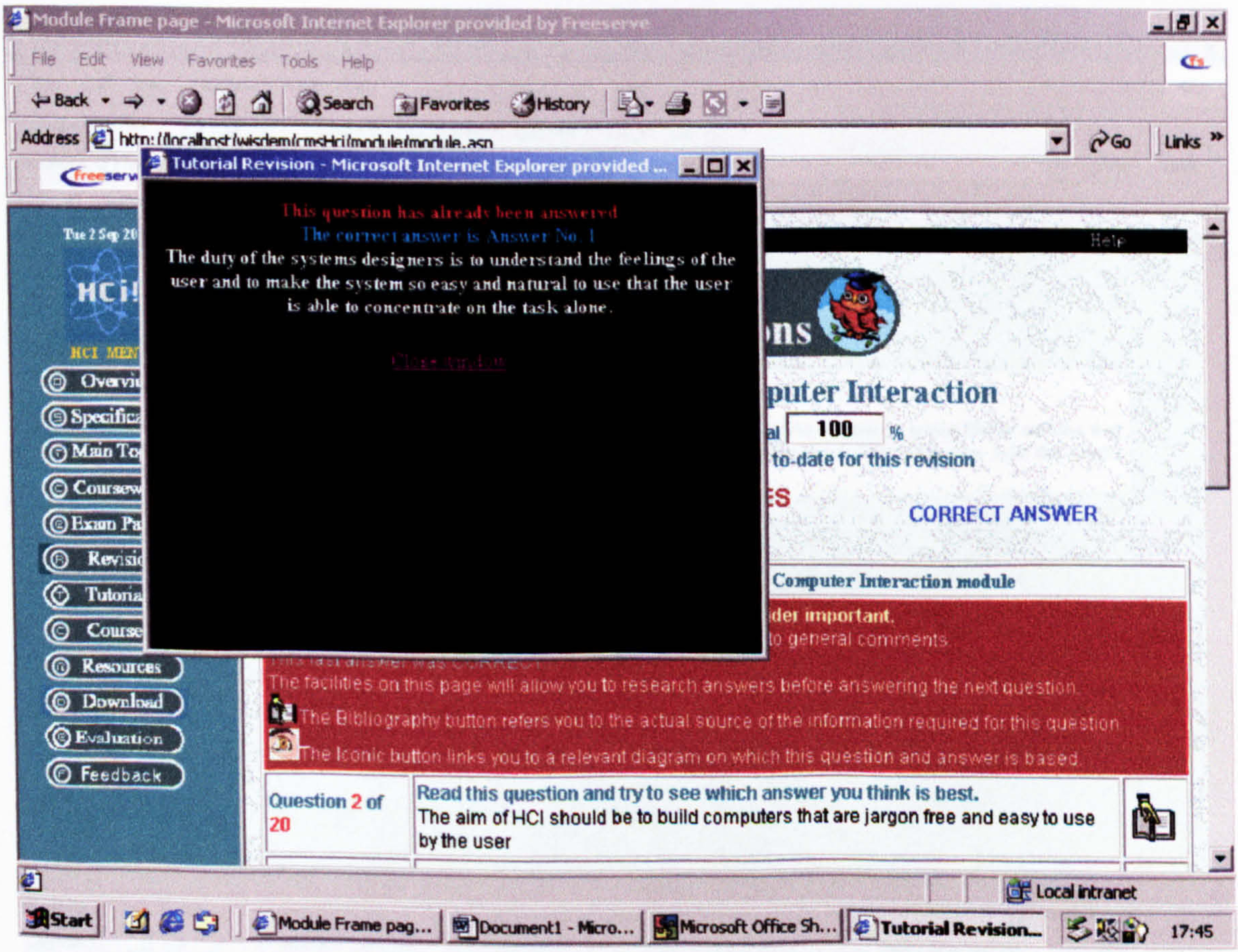


Figure 114 - Correct Answer Button output

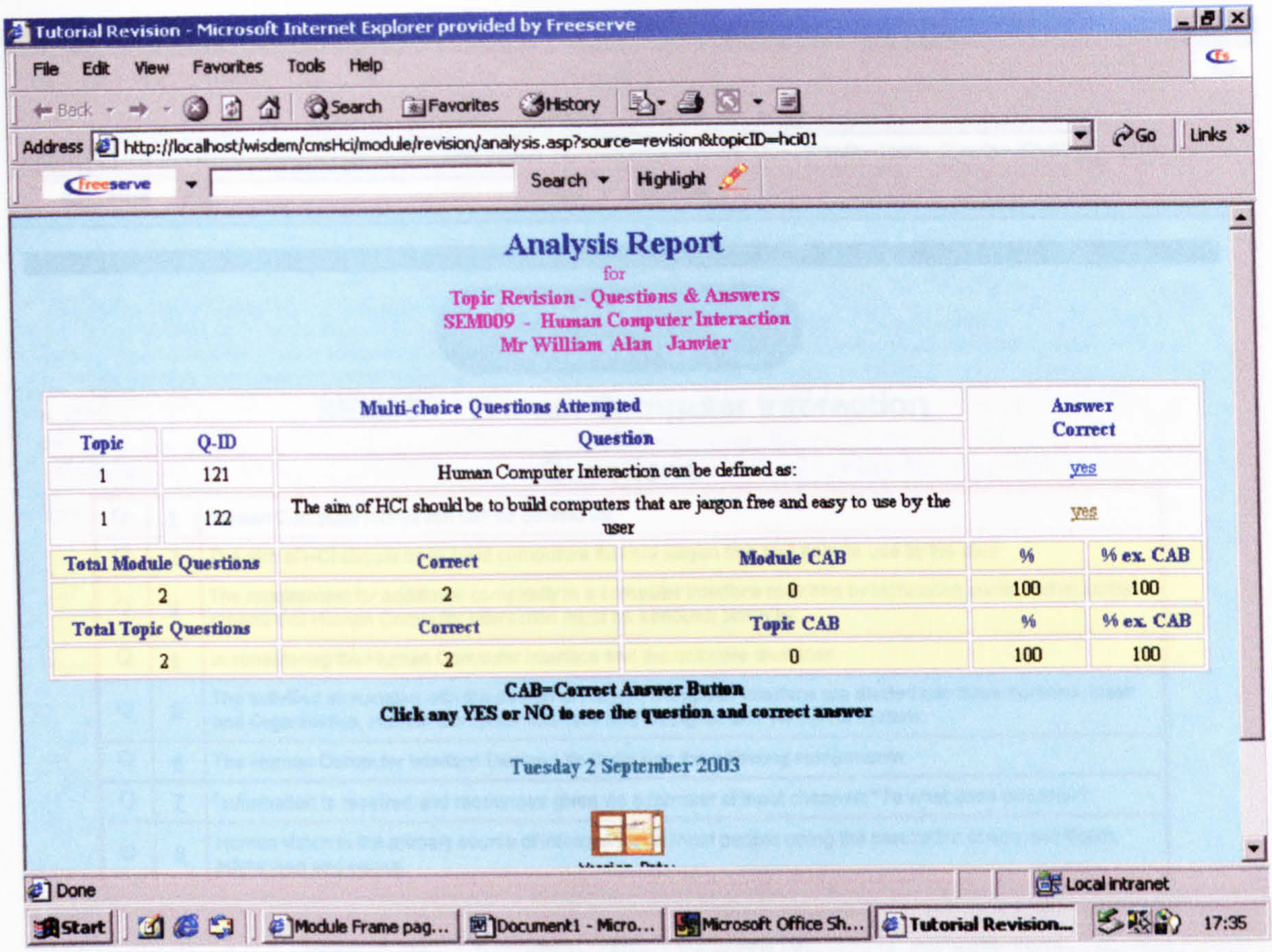


Figure 115 - Analysis Report

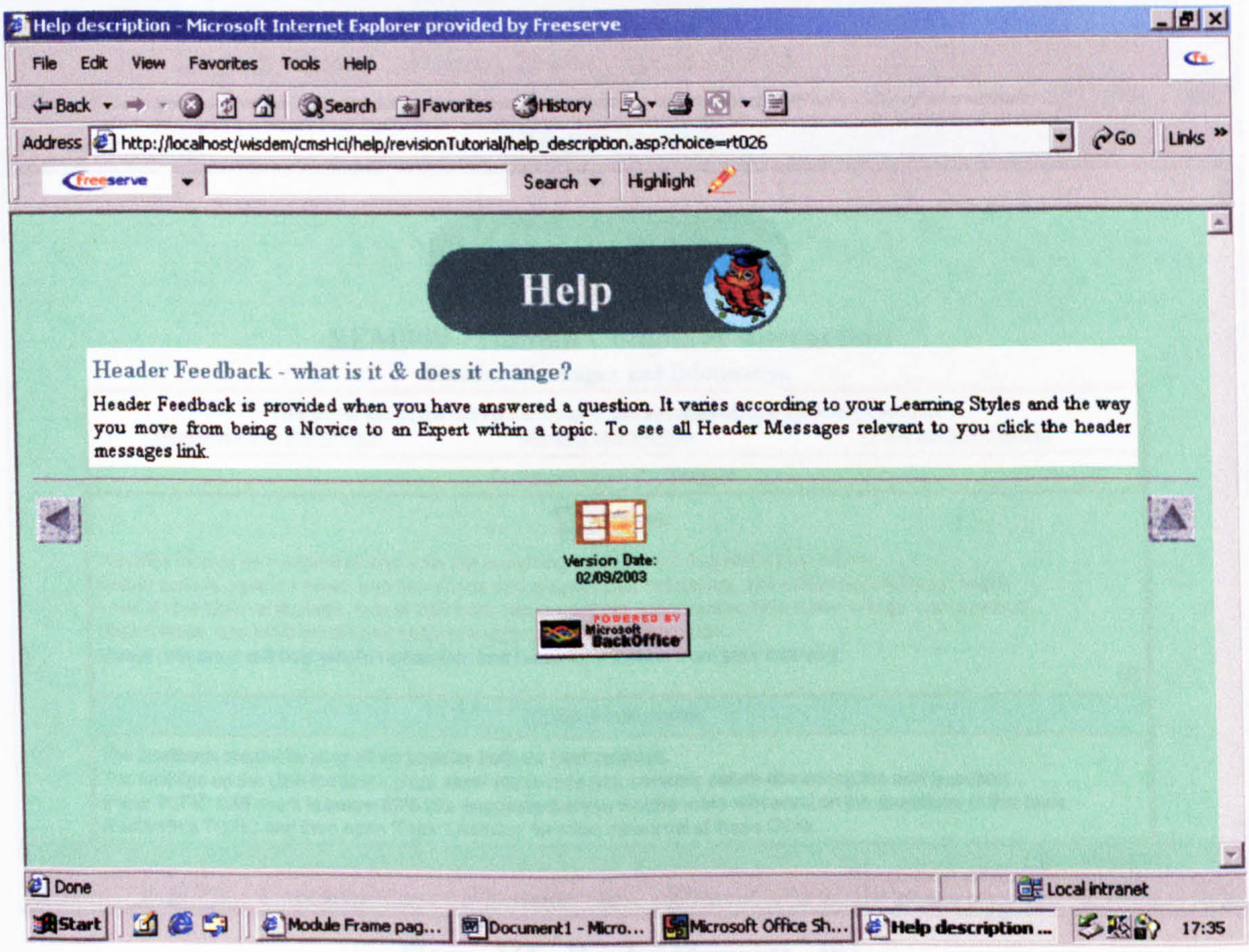


Figure 116 - Help page - 'Header Feedback' information.

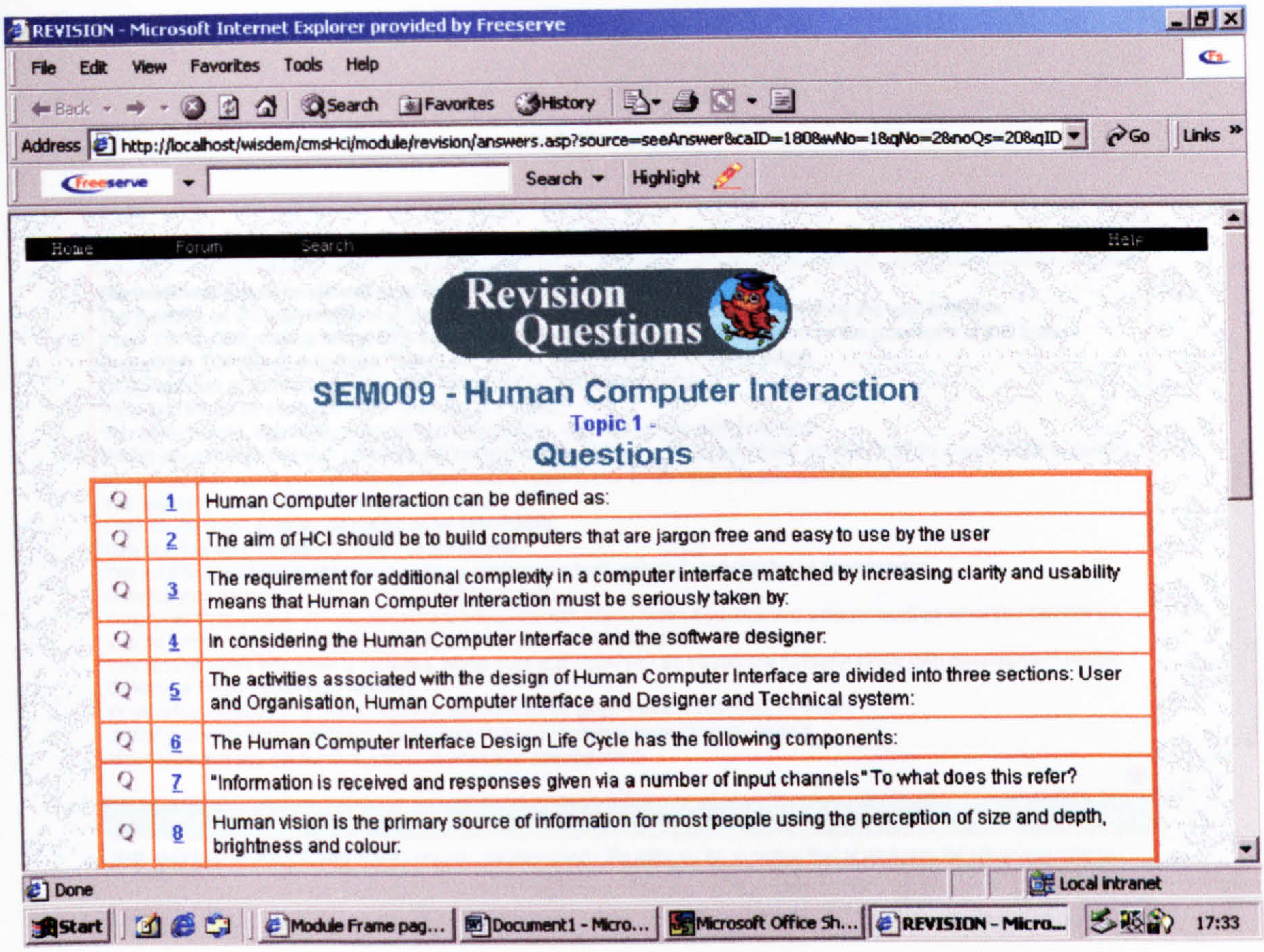


Figure 117 - Revision Questions/Answers facility

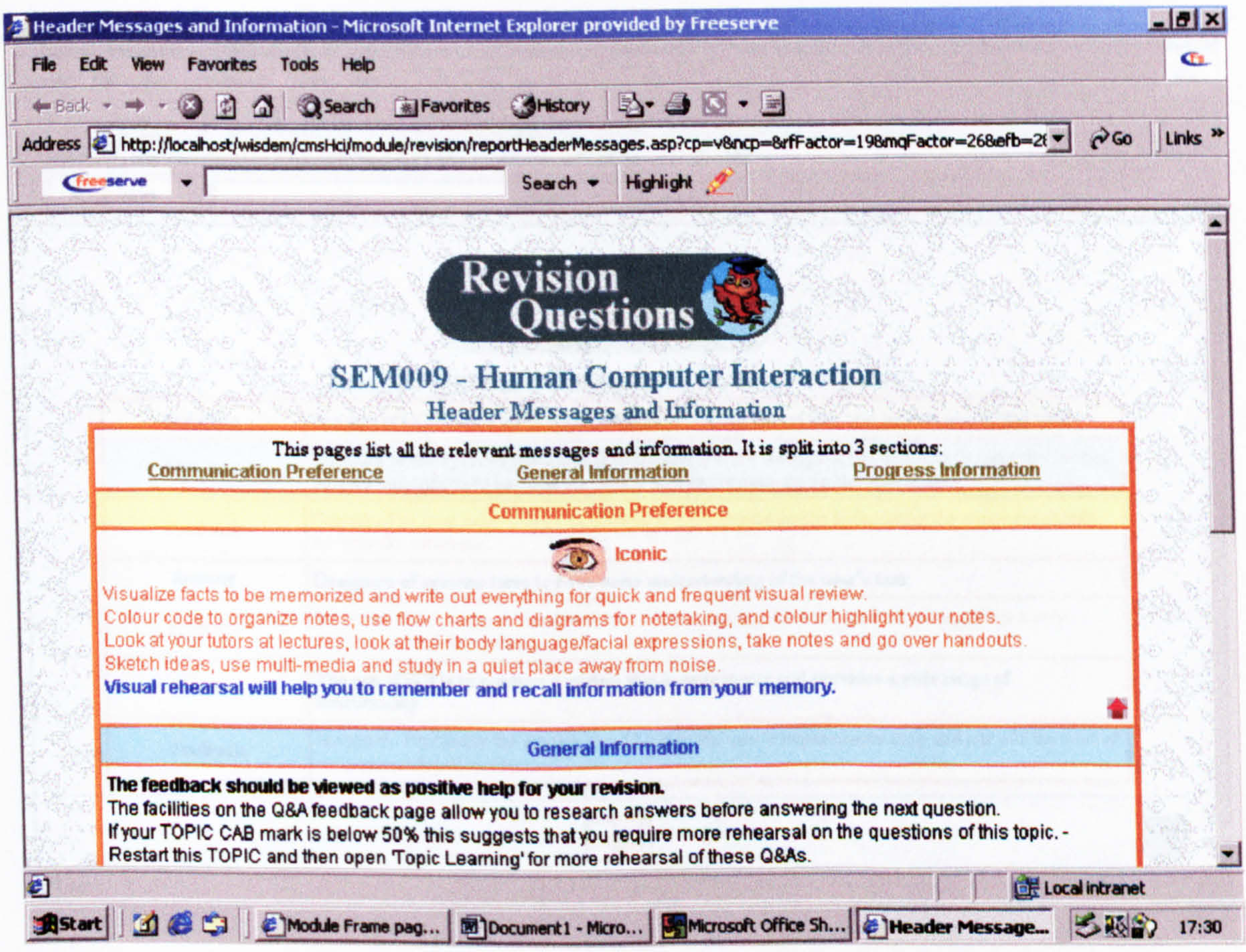


Figure 118 - Header Messages - Pt1.

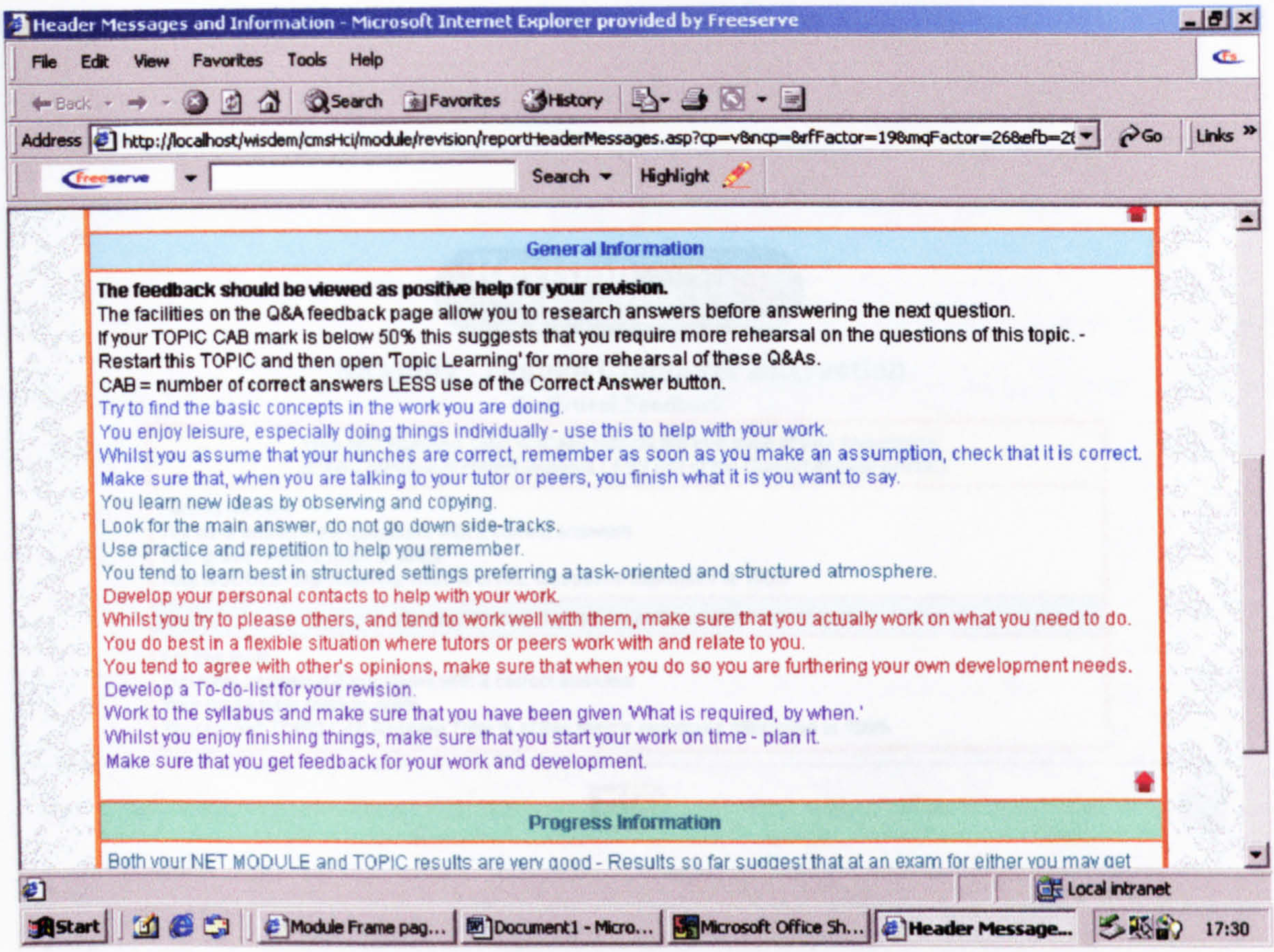


Figure 119 - Header Messages - Pt2.

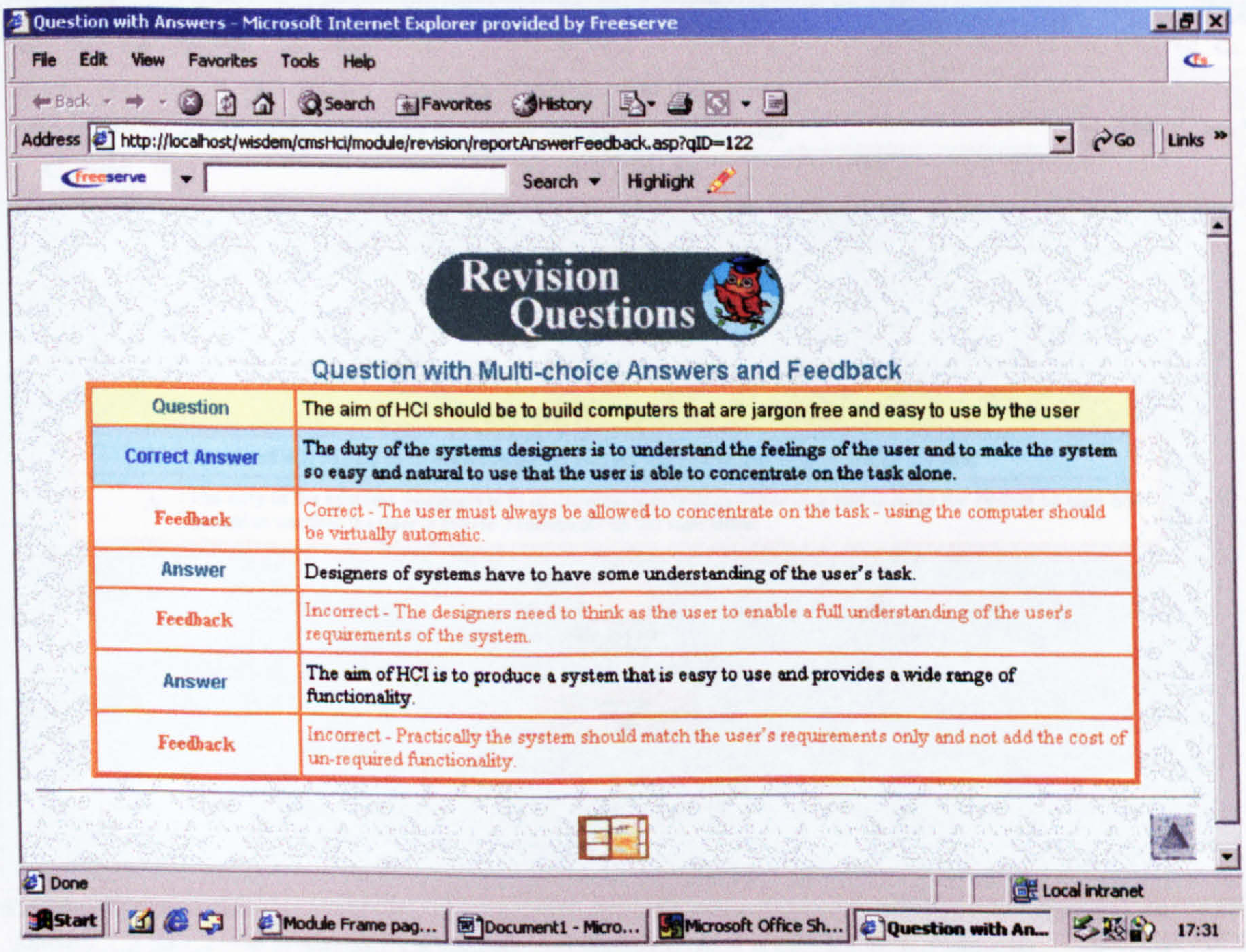


Figure 120 - Answer Feedback page

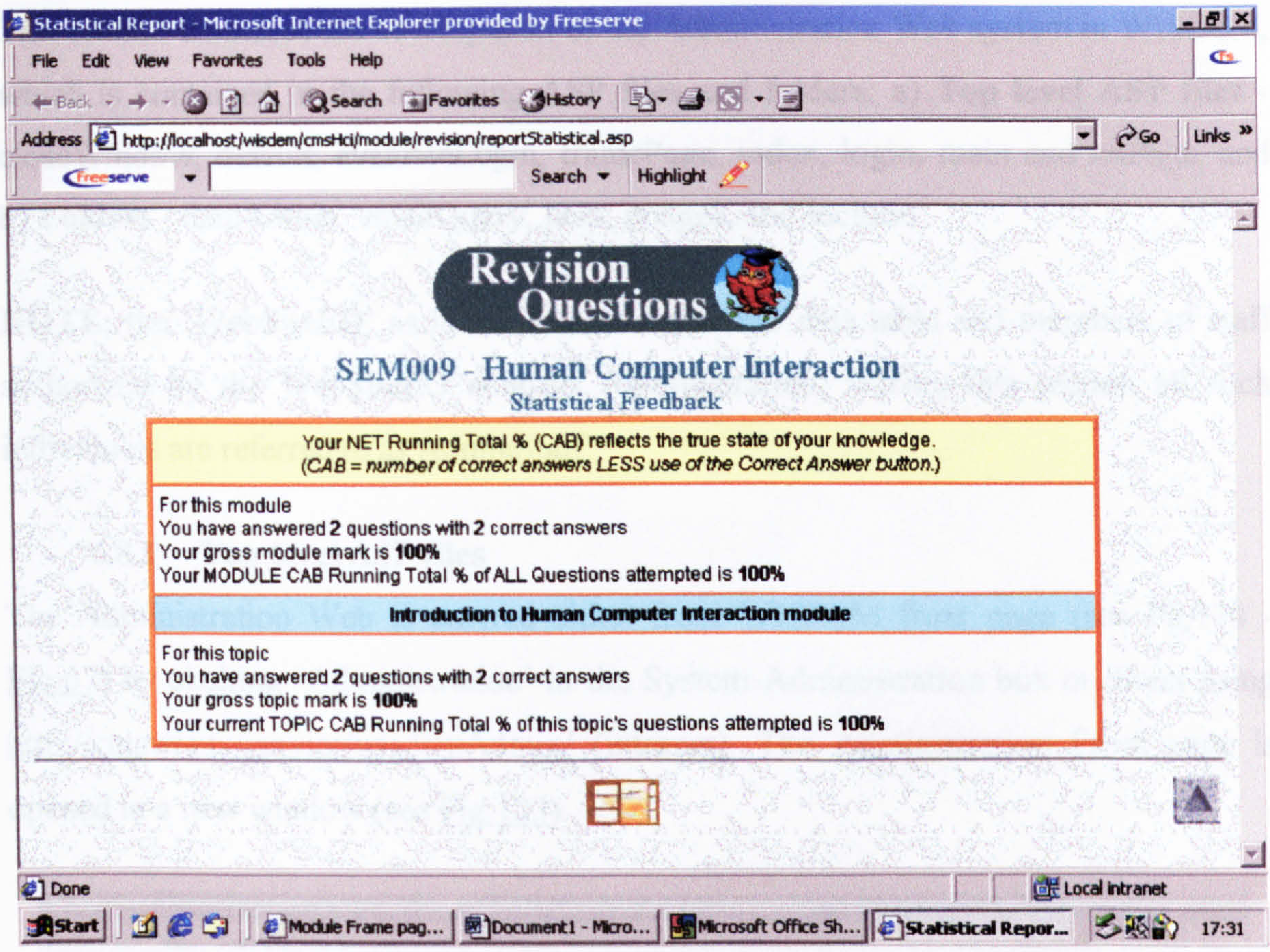


Figure 121 - Statistical Feedback

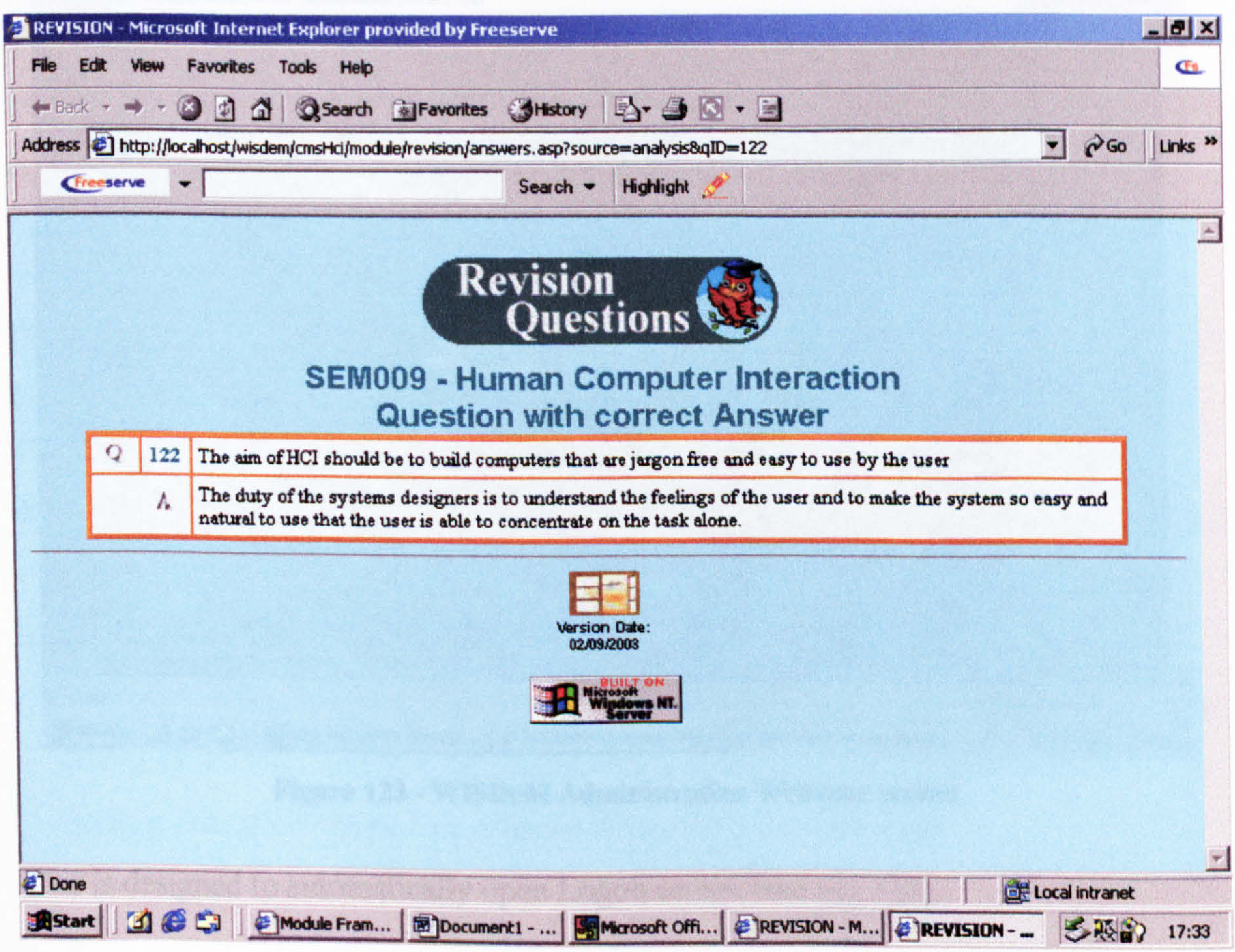


Figure 122 - Question with Correct Answer

6.8 Year 3 onwards - Administration System

This section discusses the development of the Administration Web system in WISDeM, which is contained in the following ASP files and folders: a) **Top level ASP files** - closeWindow, default, evaluateLogin, framePage, index, login, main and noPage, and b) **Folders** - dataAdmin, emailQuery, help, images, and include.

NOTE: the 'WebSiteEO' as listed in the webSiteEO data table and members of staff authorized by the WebSiteEO controls Administration. During this section all such individuals are referred to as AdminStaff.

6.8.1 Top level ASP files

The Administration Web is entered either from WISDeM front page (see Pg.138 - Fig.67) by clicking 'Administration' in the System Administration box or direct using http://cmswjanv/janvier/wisdemAdmin/ (intranet). The Administration Front page is opened in a new window (see Fig.123).

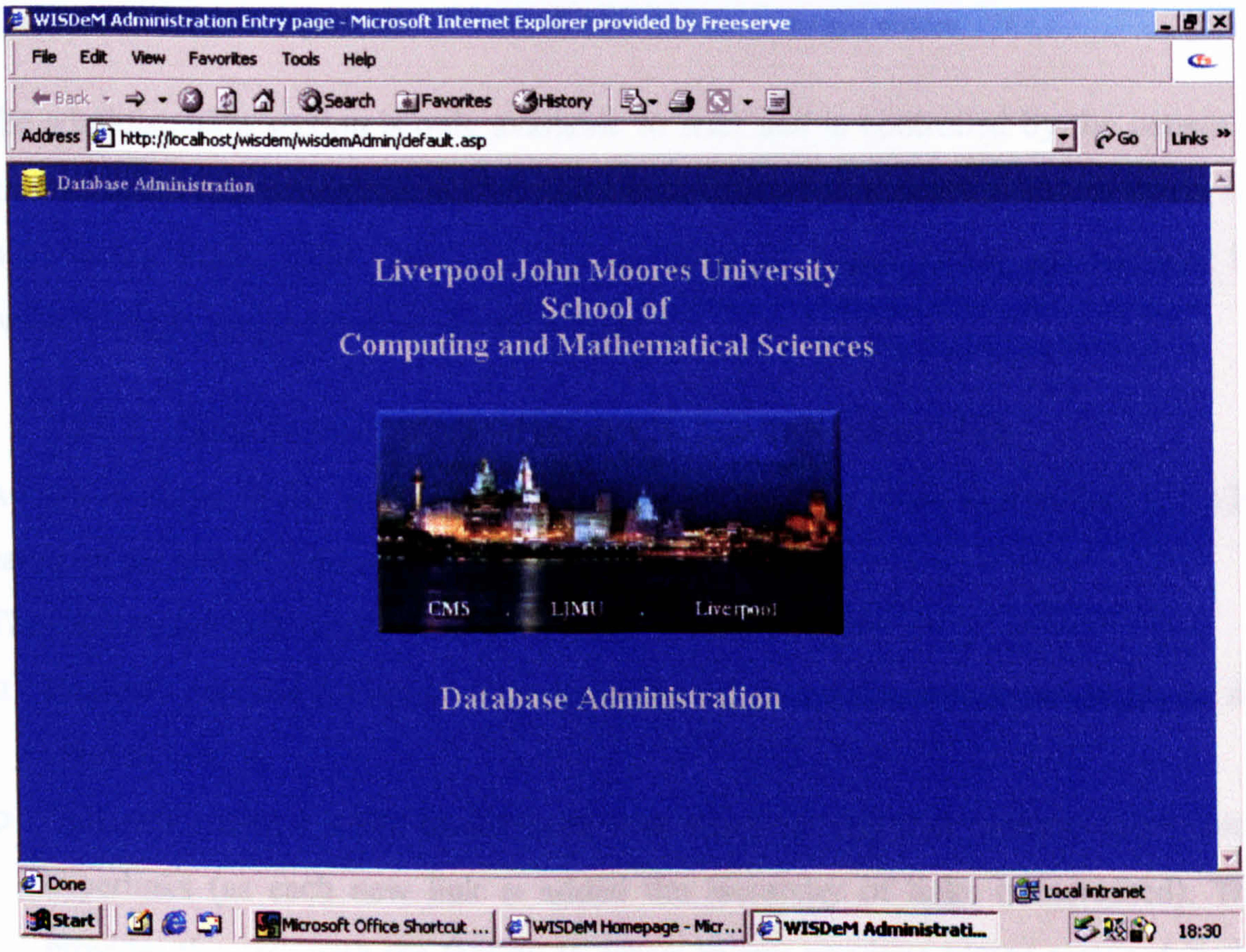


Figure 123 - WISDeM Administration Welcome screen

This is designed to automatically open Logon screen (see Fig.124).

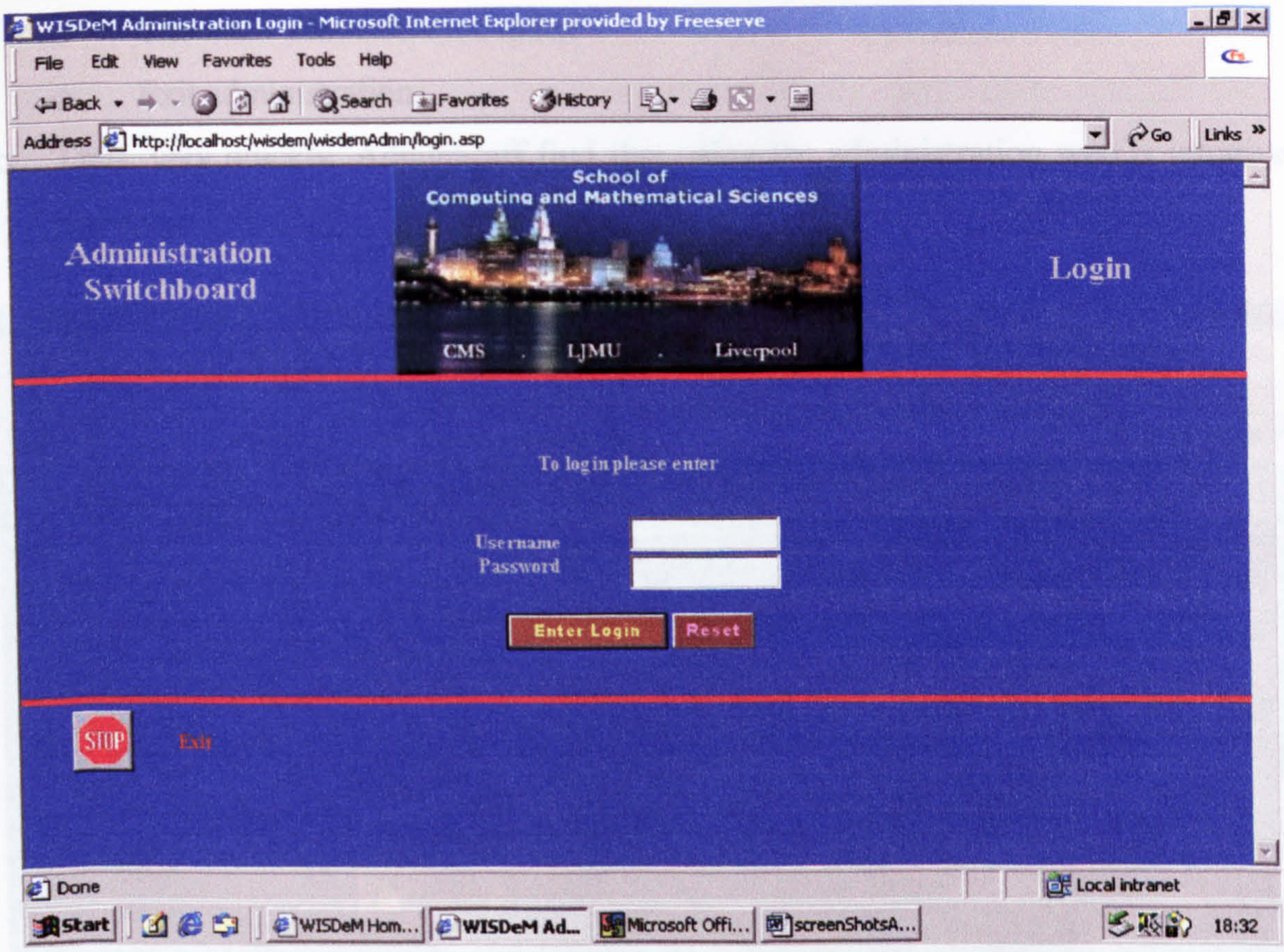


Figure 124 - WISDeM Administration Login screen

The administration section is only available to staff and is controlled by the person in control of the system and by his/her delegated authority. Successful logon opens the main index frame page (see Fig.125) an error in logon entry, as assessed by evaluateLogon, opens the closeWindow page.

6.8.2 Generic Design implemented in Administration Web.

All action pages in the administration web have the same basic design (see Fig.126) based on the five HCI principles of Good Design.

The sections for each page are: Header, Contents and Footer.

- **Header** - contains the name of the Switchboard, this is constant for all pages for the selected section.
- **Contents** - uses a white background with an upper cell that contains hierarchical hyperlinks (as each new link is added the hierarchy of links is increased). This provides the user with the facility to return to any previous screen required in this section - the contents section contains the active part of the page.
- **Footer** - this contains, as relevant, the facility to return to:
  - The administration index for the section currently being administered

- The main administration index
- Exit administration.

- Thus, very quickly, AdminStaff find that using the administration web is intuitive and easy.

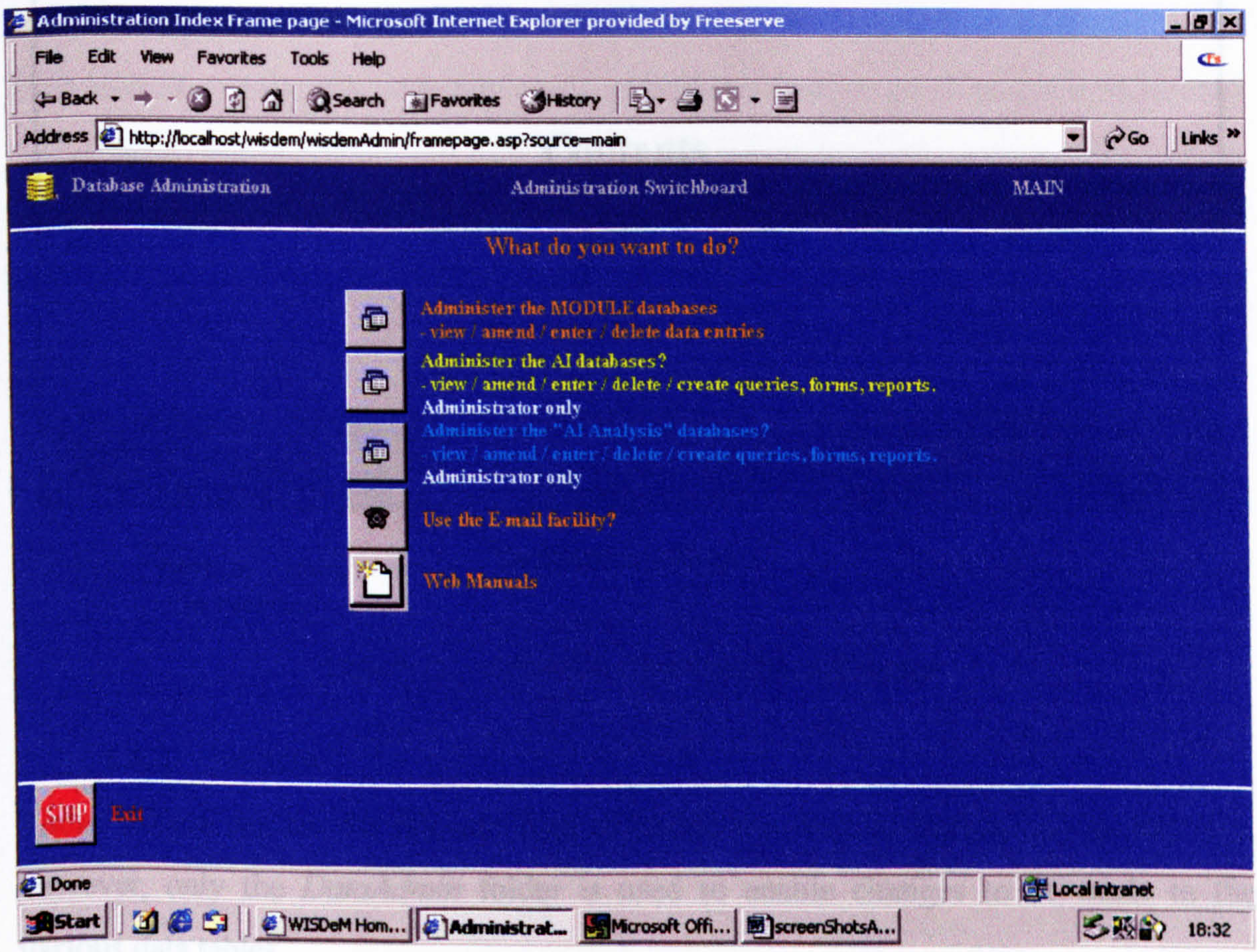


Figure 125 - WISDeM Administration Main Index screen

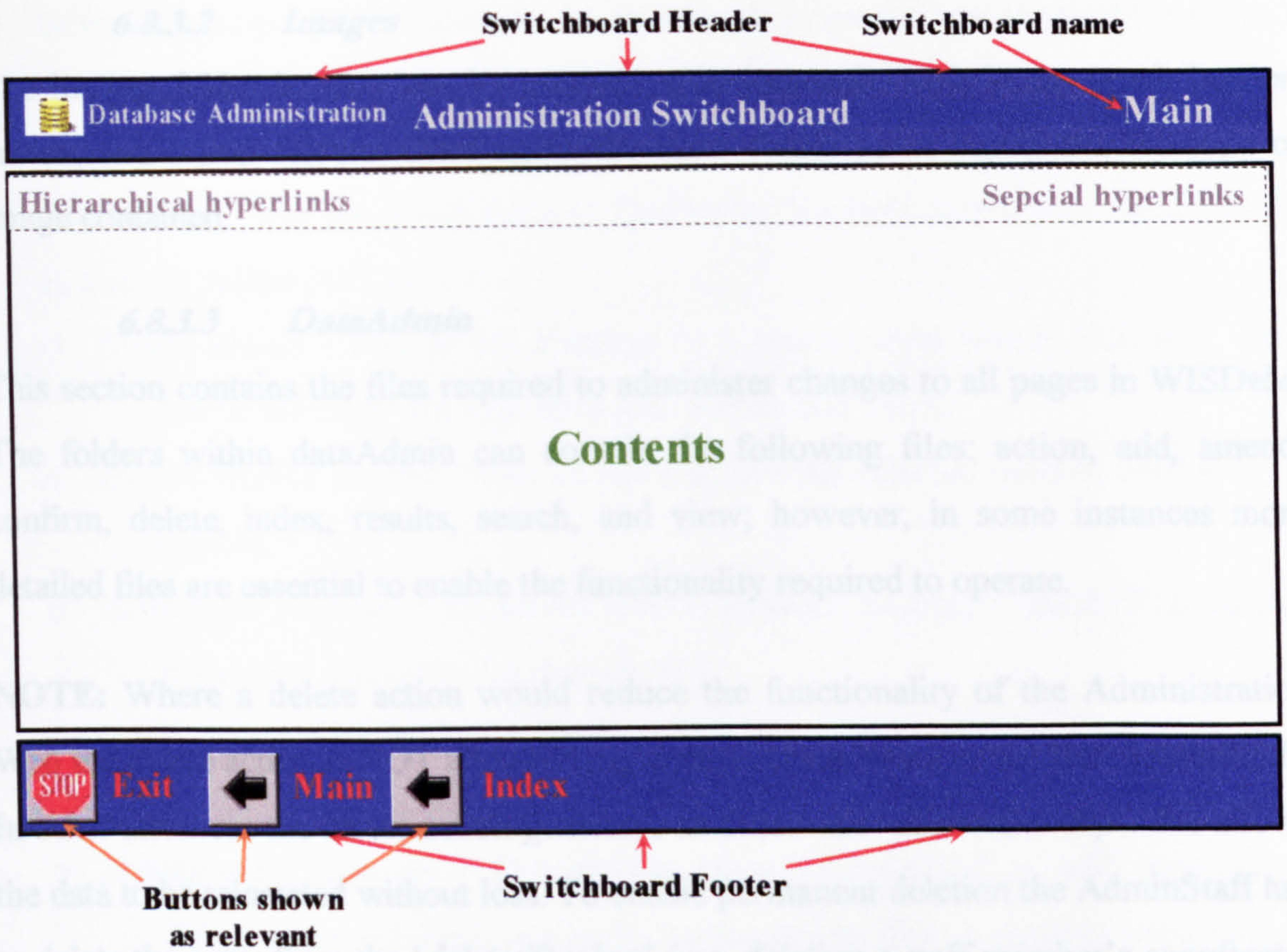


Figure 126 - Administration Switchboard design

6.8.3 Folders

These folders contain the relevant files to enable the Administration web to function; however, only the *DataAdmin* folder is used to enable changes to be made to the various data tables.

6.8.3.1 Include

This folder contains reusable code libraries: *htm-lib*, *inc-lib*, *js-lib*, *revision*, and *style-lib*. As with the main system folder '*cmshci*' these libraries contain files identified by their folder name and are used as relevant (e.g. the *inc-lib* holds the ODBC access text file *vda* that provides all virtual address names to enable the ASP pages link via ODBC to the data various tables - *vda="wisModule"*, *vdaAI="wisAI"*, *vdaMas="wisMaster"* and *vdaPed="wisPed"*, changing anyone of these changes the database to be used (*vdaAI="wisAIsql"* would change the Access database to the SQL database where the latter had the virtual address of '*wisAIsql*' without parameters).

6.8.3.2 Images

The images folder is, like '*cmshci/images*', split into animated, background, banner, button, and stamp folders. Once again the inner folder name represents the type of image contained.

6.8.3.3 DataAdmin

This section contains the files required to administer changes to all pages in WISDeM. The folders within dataAdmin can contain the following files: action, add, amend, confirm, delete, index, results, search, and view; however, in some instances more detailed files are essential to enable the functionality required to operate.

NOTE: Where a delete action would reduce the functionality of the Administration Web the delete action is NOT allowed (e.g. removing the name of the last AdminStaff). In other instances the delete action generates an automatic '*deletedBackup*': this allows the data to be reinstated without loss. To enable permanent deletion the AdminStaff has to delete the entry from the '*deletedBackup*' (e.g. deleting a staff member's coordinates loses a lot of data, this action is backed up to the *deletedStaff* table to save potentially vital data which may otherwise be inadvertently lost by a mistake in deleting an entry. This requires a second deletion to make it permanent).

Each folder is designed as per Pg.195 - Generic Design implemented in Administration Web and the standard Administration Switchboard design (see Fig.126).

There are twenty-two folders that change the data table entry (of their name - viz. *Counters* equates to the data table *counters*):

- **Acknowledgements** - allows: add, amend, and delete names of students, etc. who have contributed to the pedagogical knowledge with sections in Courses (see Pg.152 - Fig.82).
- **AdminIndex** - allows: add, amend, and delete (see Fig.127).
- **Counters** - allows: add, amend, and delete. This database holds the web site access counter and module access counters.
- **Course - Feedback** - allows: delete, delete confirm, view, and user.
  - **View** output lists Date, Feedback Message and User and can be viewed by: Date, User, Date & User, and User & Date sequential listings.
  - **User** output gives the full coordinates of the user.

- **DeletedBackup - Staff** - allows: delete, search, reinstate, and view any entries in this data table (see Fig.128 & Fig.129 for design and functionality).
- **EmailList** - allows: delete or view any entries in this data table.
- **Evaluation** - has three sub-folders: Questions, Reports and Users. This section allows the AdminStaff to:
  - *Delete entries* - This screen displays ALL entries from which ALL or 1 entry can be selected: this applies to user entries and users.
  - *Delete Module entries* - This screen displays the selected module entries to be deleted,
  - *Administer Reports* - This screen section allows the administration of completed evaluation reports by Module or ALL:
    - View - Analysis or Comments
    - Delete - Analysis or Comments
  - *Administer Questions* - This section allows AdminStaff to add, amend and delete questions displayed in the Evaluation facility: it requires some sixteen interlocking files to achieve this functionality (see – Fig.130).
- **Help** - allows: add, amend, delete or view any entries in this data table for either module or course help.
- **Module - Feedback** - allows delete, delete confirm, view feedback and student coordinates. The view facility allows view of all entries or selected entries (see Fig.131).
- **Module - Forum** - allows delete, delete confirm, view feedback and student coordinates. The view facility allows view of all entries or selected entries.
- **Specification** - *View* - see selected entry, Amend - alter an entry, *Default* - replace selected entry with 'Default entry, *Indicative References* - 1) Create new reference, 2) Link module to existing reference/s, 3) Delete module link to reference/s, and 4) Delete reference if not in use.
- **Staff** - allows: View, Amend, Add New, Delete Entry, Immediate UNDELETE, DeletedBackup administration (this links to the *DeletedBackup* facility above) and Staff Search (by any string entry - viz: 'gh' would provide a list of all staff forenames/surnames with the consecutive letters 'gh' anywhere within the name string) (see Fig.132 & Fig.133)
- **Student** - allows View, Amend, Add New, Delete Entry, Student Search and Deleted Backup Administration (as per staff). The following figures demonstrate

the inner hyperlink hierarchy within the top of the contents section of the page (See Fig.134, Fig.135 & Fig.136).

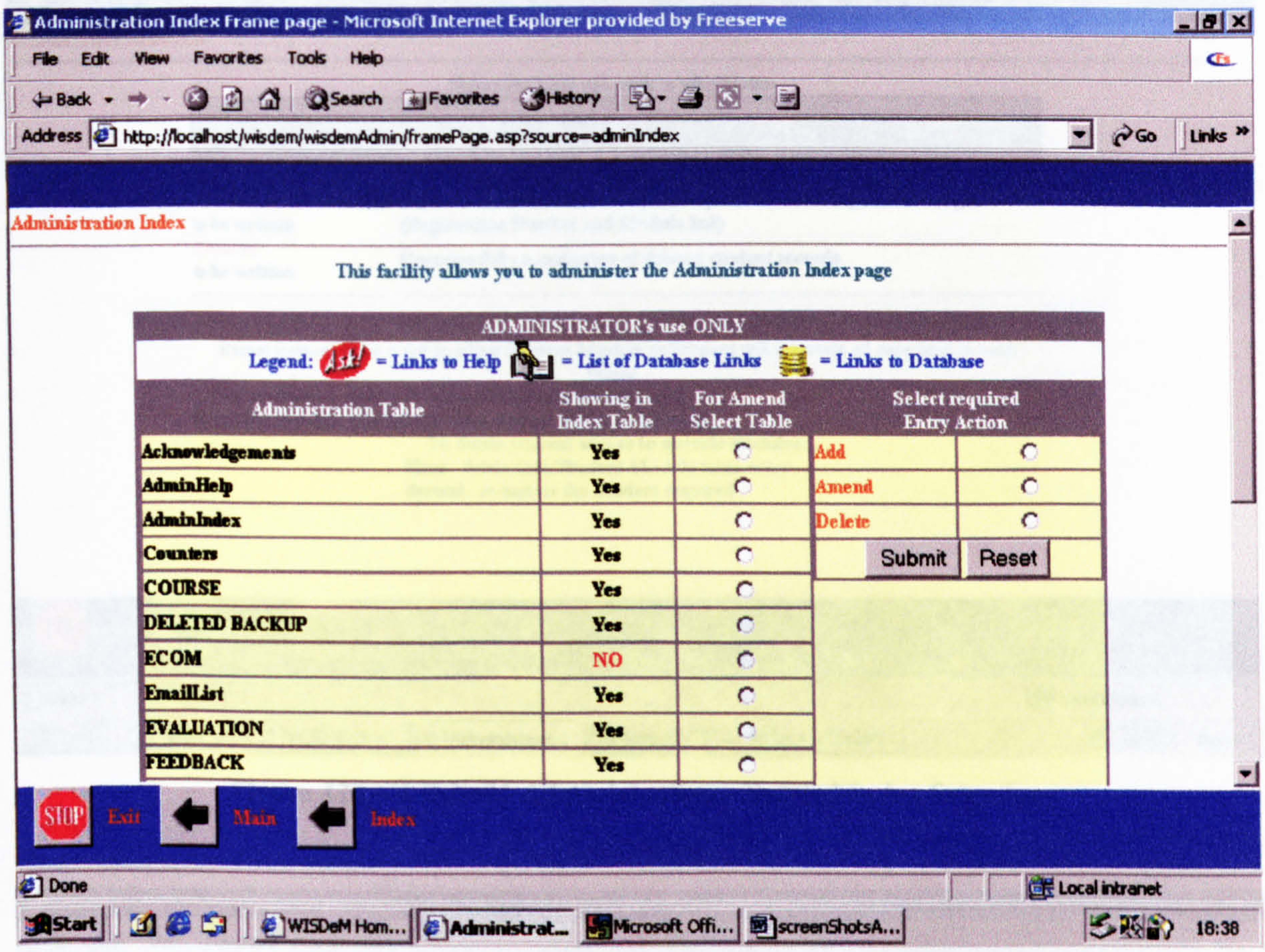


Figure 127 - WISDeM Administration - Administration Index

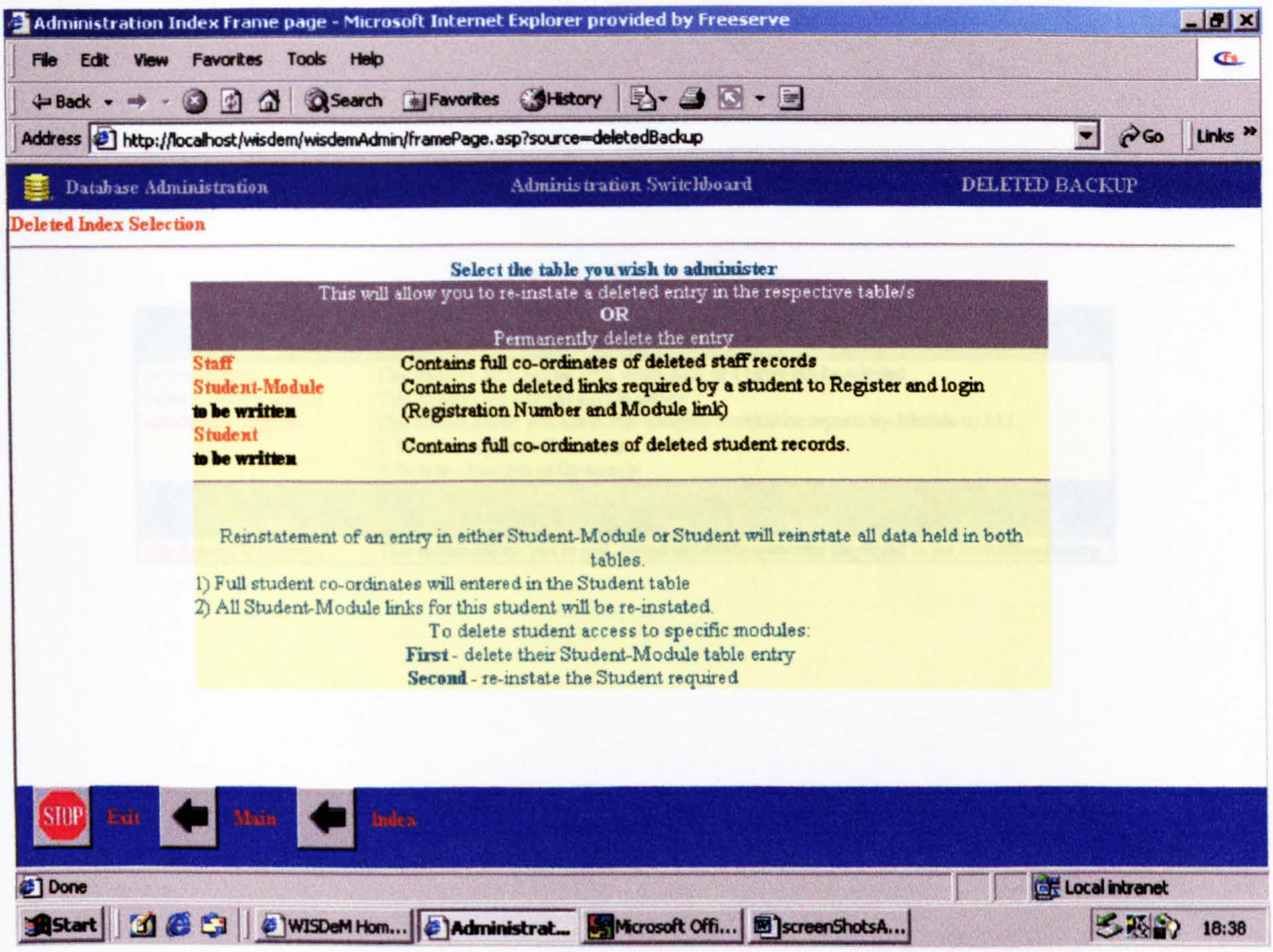


Figure 128 - WISDeM Administration - Deleted Index Selection

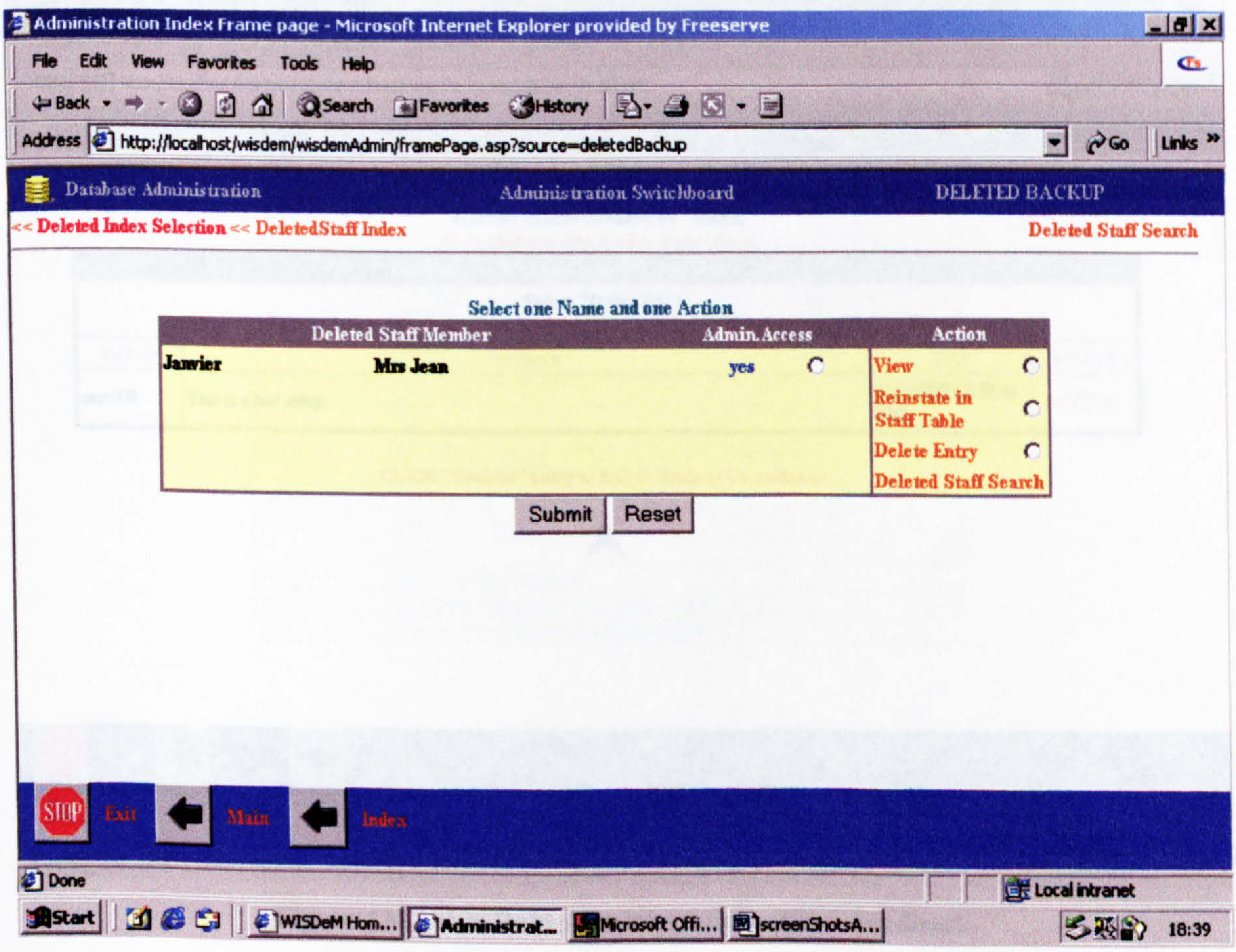


Figure 129 - WISDeM Administration - Deleted Staff Index

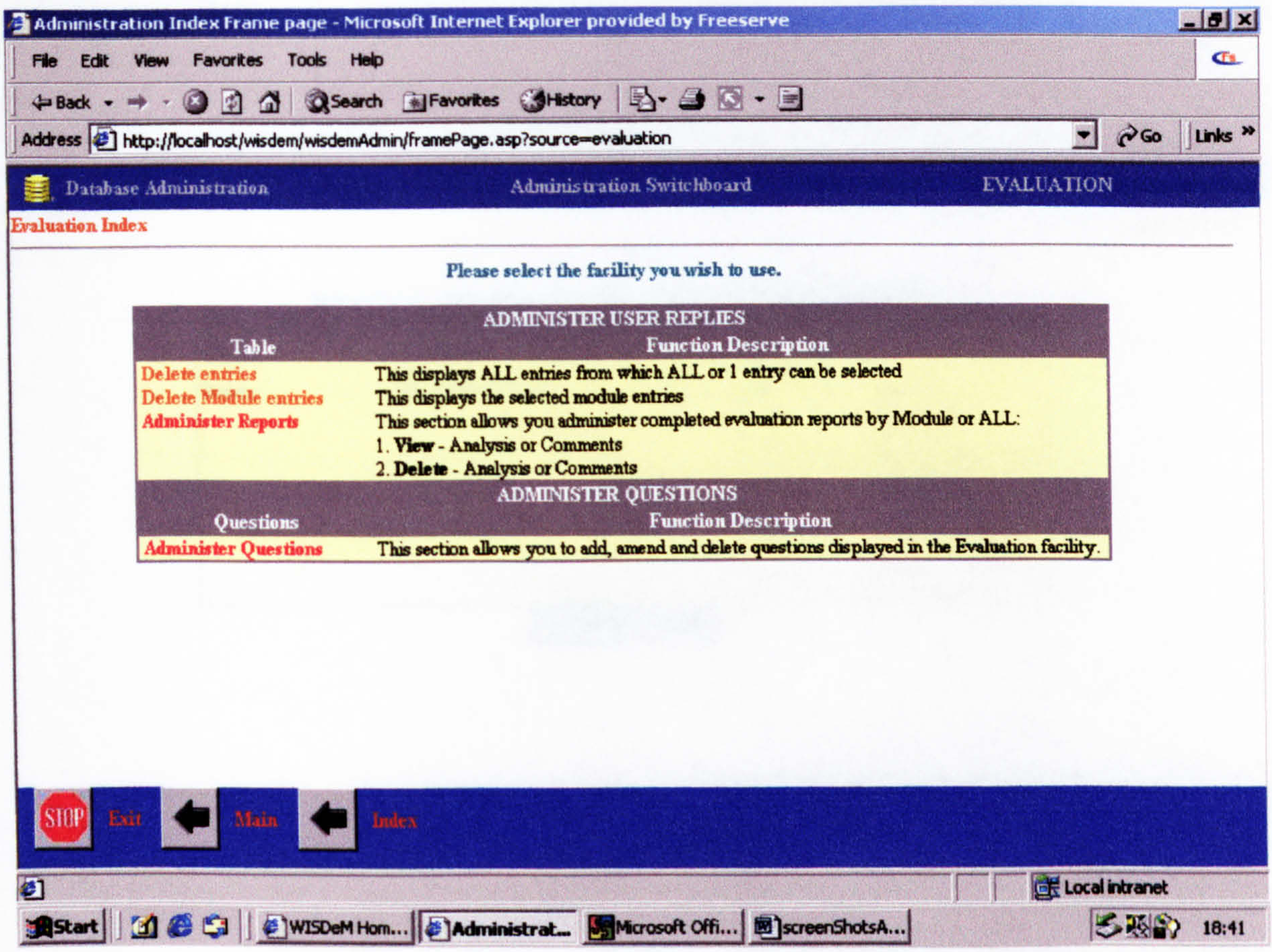


Figure 130 - WISDeM Administration - Evaluation Index

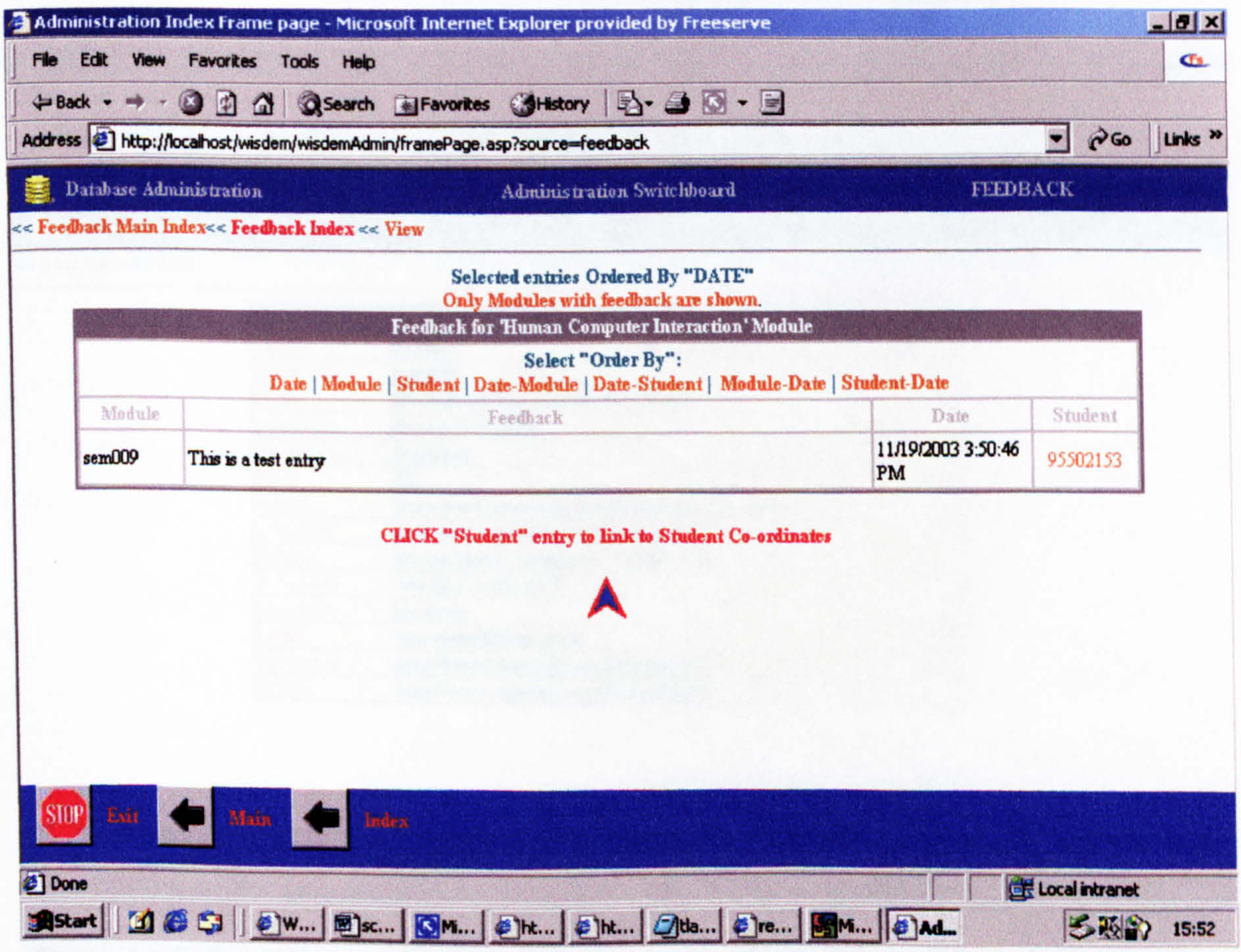


Figure 131 - WISDeM Administration - View Feedback

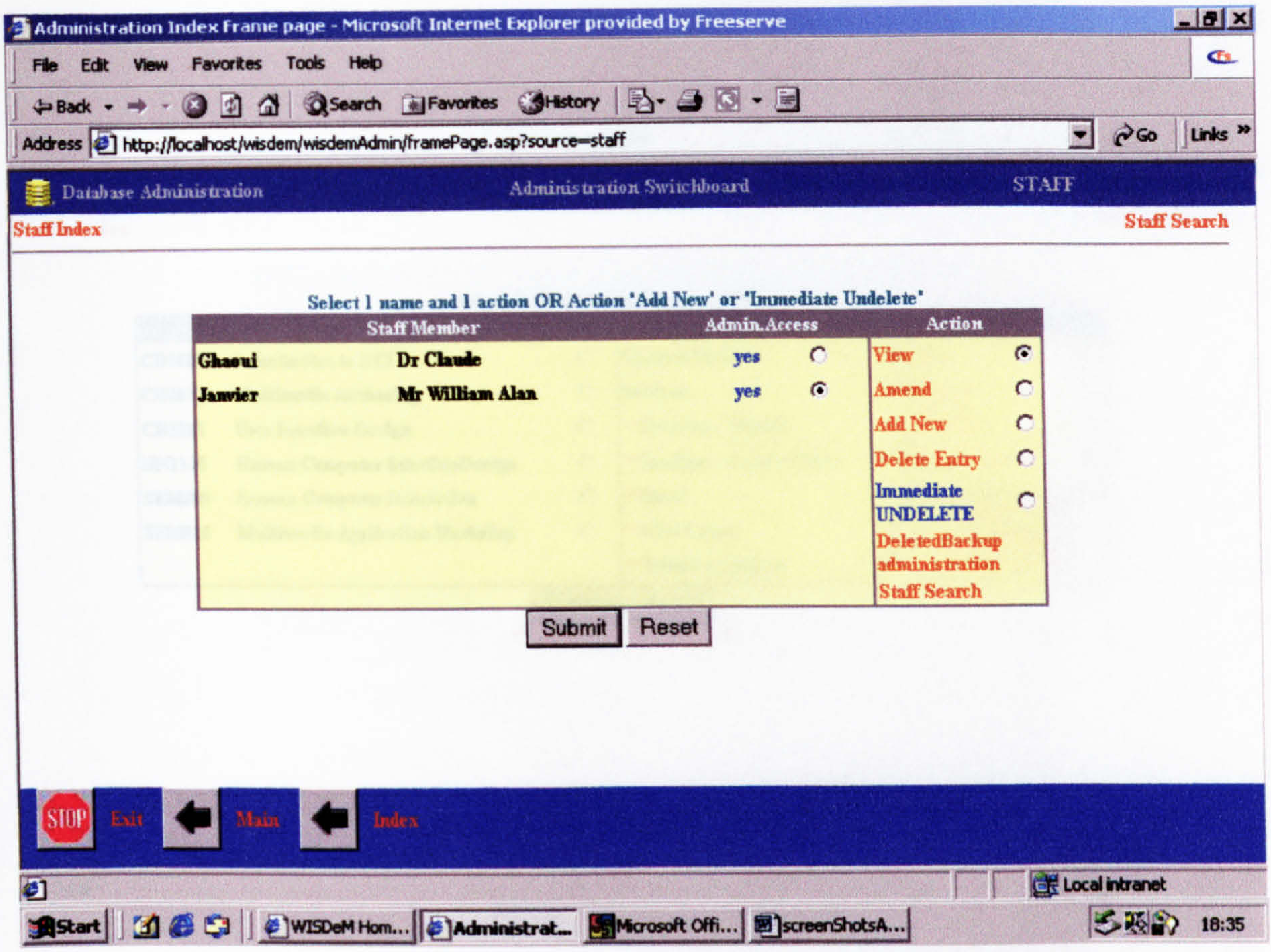


Figure 132 - WISDeM Administration - Staff Index

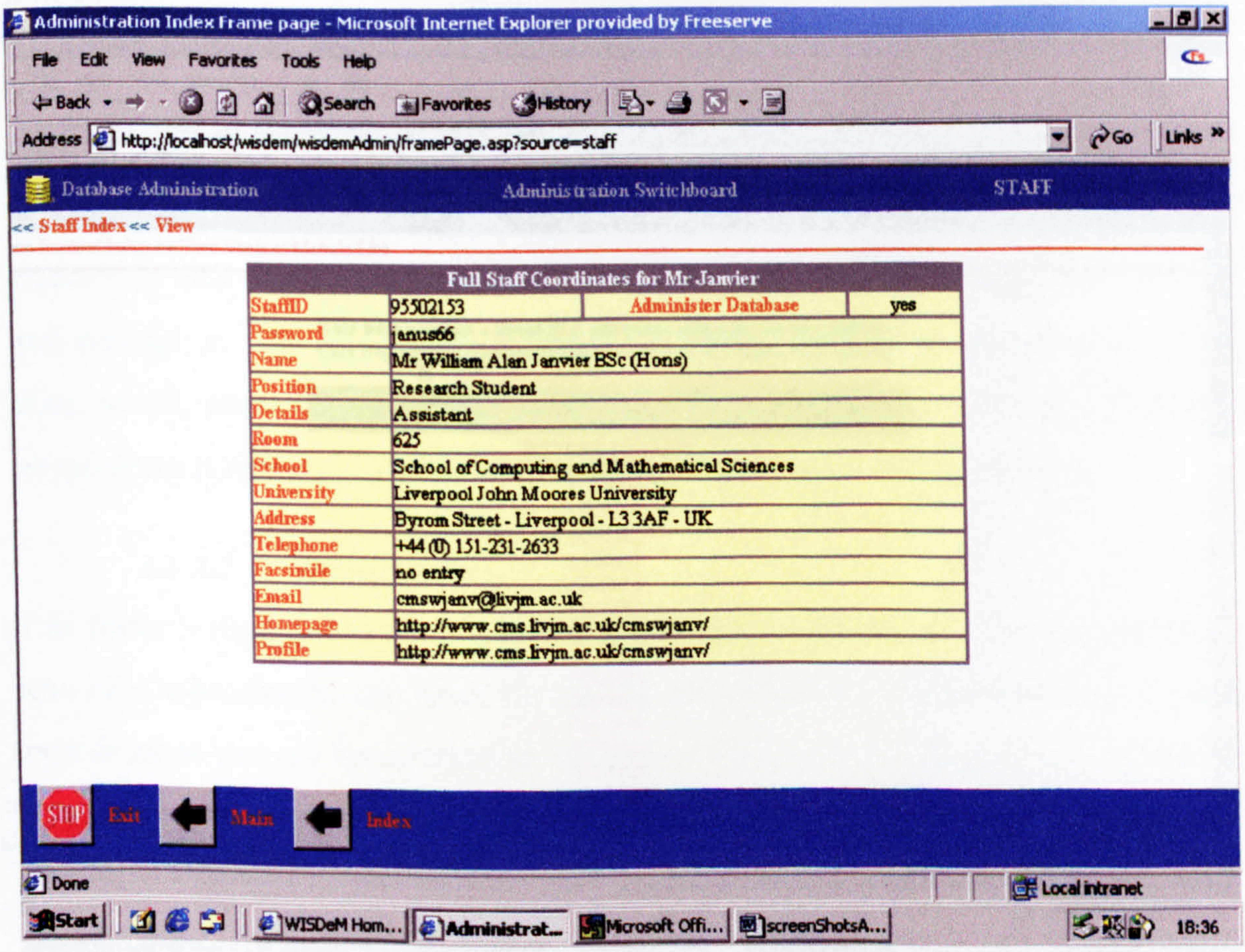


Figure 133 - WISDeM Administration - View Staff coordinates

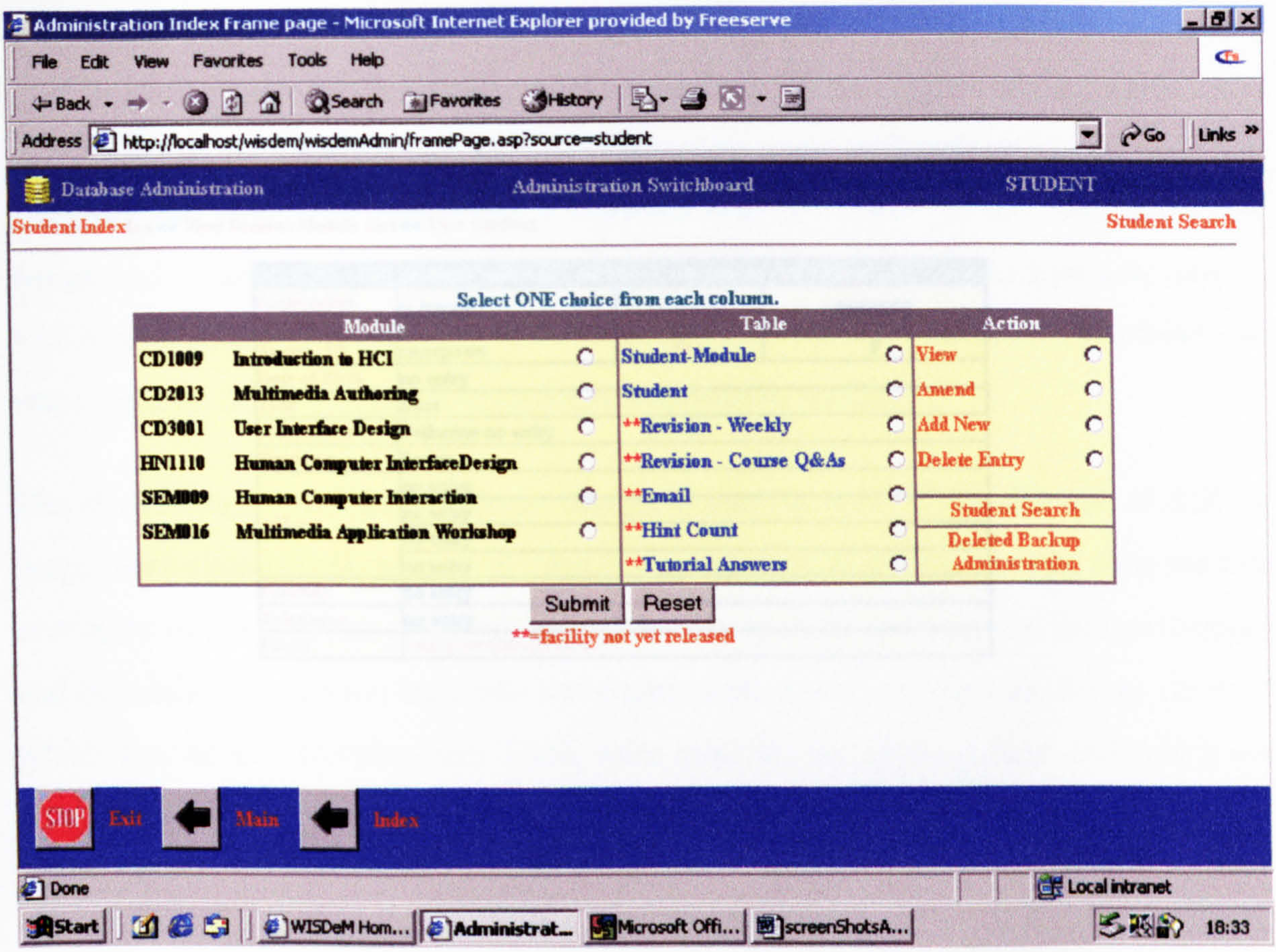


Figure 134 - WISDeM Administration Student Index screen

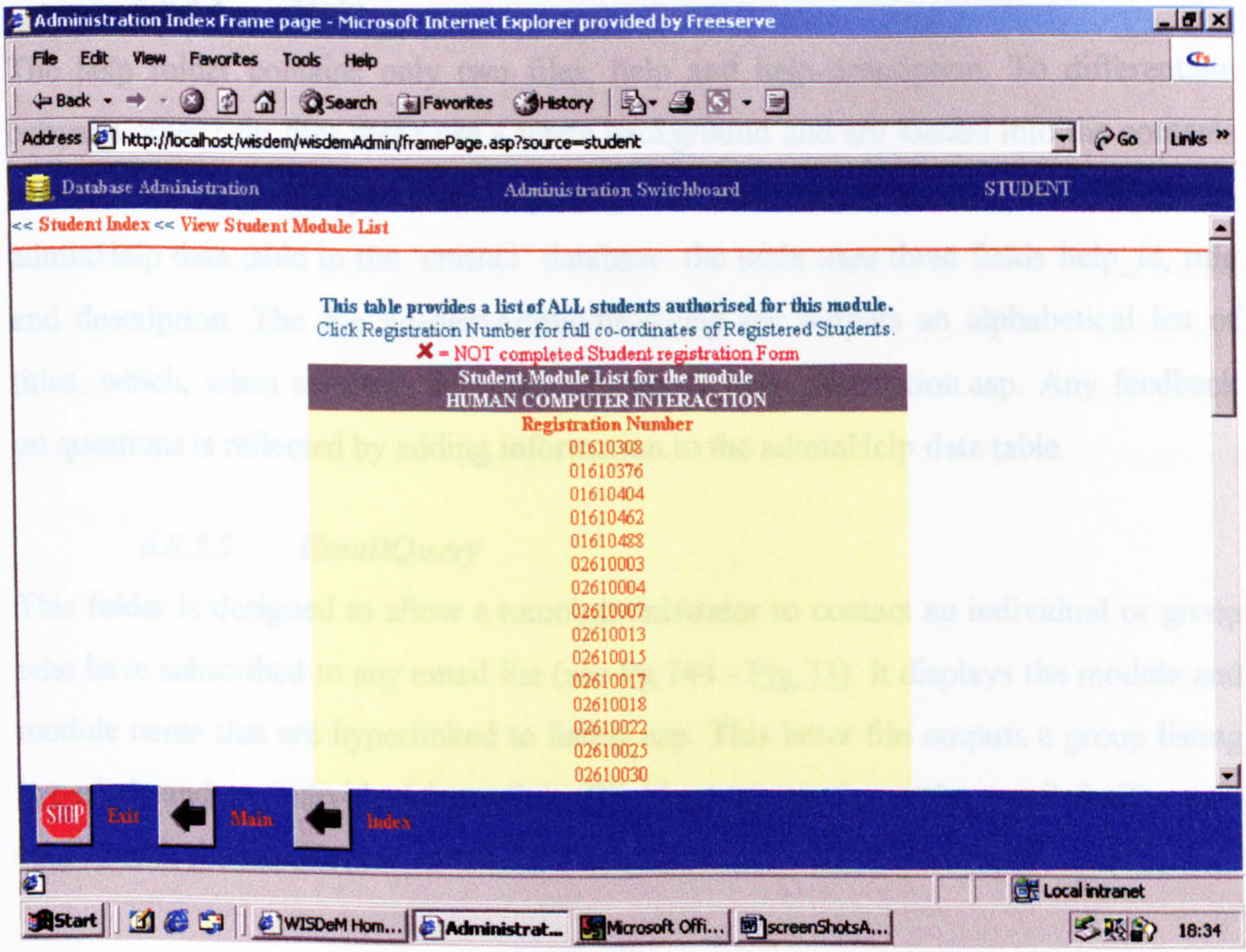


Figure 135 - WISDeM Administration - View Student Module List

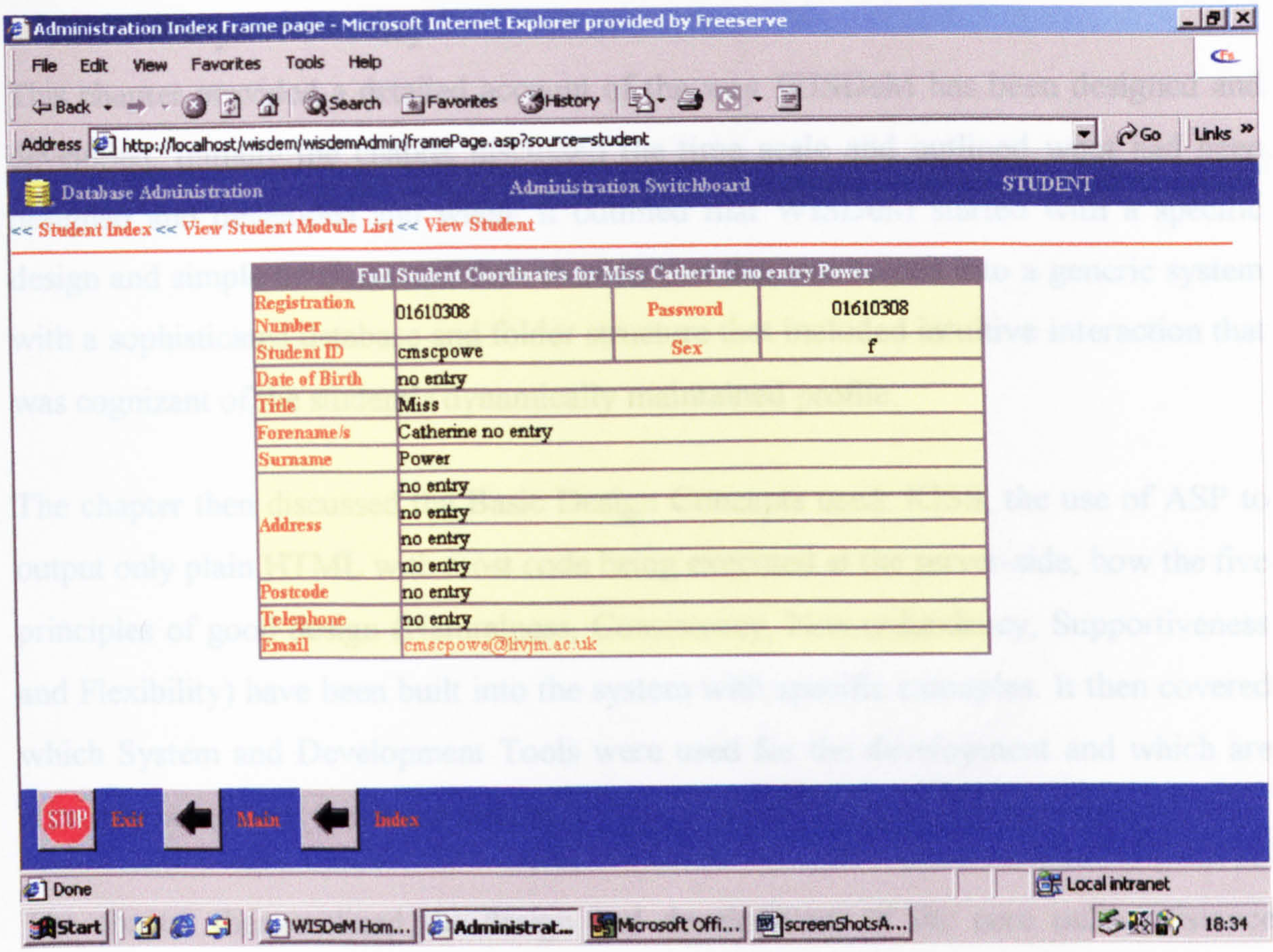


Figure 136 - WISDeM Administration - View Student coordinates

6.8.3.4 Help

The help folder contains only two files, help and help-description. To differentiate between other help files these use a white background and are loaded into the contents frame. This help file provides help only for the Administration Web from the adminHelp data table in the 'cmshci' database: the table uses three fields help_id, title and description. The file wisdemAdmin/help/help.asp outputs an alphabetical list of titles, which, when selected, automatically opens help_description.asp. Any feedback on questions is reflected by adding information to the adminHelp data table.

6.8.3.5 EmailQuery

This folder is designed to allow a tutor/administrator to contact an individual or group who have subscribed to any email list (see Pg.144 - Fig.73). It displays the module and module name that are hyperlinked to listing.asp. This latter file outputs a group listing hyperlink and an individual hyperlink. Clicking any produces the email facility pre-loaded with the selection.

6.9 Chapter Summary

This chapter provided a detailed account of the way WISDeM has been designed and developed. Initially the chapter discussed the time scale and outlined what had been designed and developed and when. It outlined that WISDeM started with a specific design and simple database and then showed that this was turned into a generic system with a sophisticated database and folder structure that included intuitive interaction that was cognizant of the student's dynamically maintained profile.

The chapter then discussed the Basic Design Concepts used: KISS, the use of ASP to output only plain HTML with most code being executed at the server-side, how the five principles of good design (Naturalness, Consistency, Non-redundancy, Supportiveness and Flexibility) have been built into the system with specific examples. It then covered which System and Development Tools were used for the development and which are currently being used to run the system.

The chapter then outlined the design and development of the core online distance learning section in years one and two and then discussed the Intuitive Interactive section (Multi-choice Q&A) that was developed after this. In this section some depth of detail was provided discussing the work the algorithms play in outputting relevant data that matches the student's updated profile. It also discussed the fact that the student has control over this output and the way the information is released.

Finally the chapter briefly covered the design and development of the Administration System and showed that the tutor has the responsibility of creating MS Word, MS PowerPoint, MS Excel and Adobe PDF files and saving them as directed in the pedagogical specification. All other changes are made via the Administration front-end and database entries.

CHAPTER 7

A SCENARIO

7 A Scenario

This chapter covers:

- The Student, Adrian, logging on
- The Student Profile – Initial
- Revision - Topic Learning
- Revision – Topic Testing
- Revision – Q&A Page Facilities & Student Model Status Update

7.1 Introduction

This chapter provides a scenario of a typical student, though somewhat perfect, called Adrian. Adrian is a composite of students interviewed and observed during the evaluation and much of the reporting is taken from the discussions held and the observations made during the evaluation of the system. It takes the reader systematically through WISDeM's system with relevant comments being made to explain what the system is doing and why.

Adrian logs on and then goes through the stages to create his profile: both the results of creating a profile or not are discussed, the CP and LS psychometric tests and reporting are covered. Then the use of Topic Learning and the way Adrian uses it are covered with relevant comments. He moves on to use Topic Testing first using one method and then another (he did not like losing marks): this section discusses memory rehearsal and the way that the system encourages this. Finally this chapter overviews the facilities Adrian sees in multi-choice Q&A.

7.2 The Student - Adrian

A new student, Adrian, connects to WISDeM and initially sees the opening window. This changes to a screen (see Pg.135 - Fig.64) that asks his to select his school. After selecting "the School of Computing and Mathematical Sciences - HCI" Adrian is routed to the WISDeM Module server handling his module (see Pg.138 - Fig.67). He follows his tutor's instructions and clicks the 'Module Registration' hyperlink and follows the instructions for registering on the system. At the end of registration a module selection screen appears on his PC and he clicks on the module he wishes to study – a logon screen appears.

7.3 Student Profile - Initial

He is required to logon to the system using his University Registration ID, password and Module selection: he enters just his StudentID and the password he created at registration. The system checks for *userNew* or *userExisting*: Adrian is new to the system; the psychometric test selection screen opens (see Pg.163 - Fig.93). Adrian reads the information and decides that anything that might help him to learn would be useful; however, before he selects 'Yes' he reads the 'Project Details document' (see Pg.290) and decides to answer the psychometric questionnaires - he selects 'YES'.

The system provides each new user with the facility to:

- Select either an interactive route or a non-interactive route. By selecting the former the student opts to complete the two questionnaires, or the latter, skip the questionnaires and enter the module directly. The latter provides no intuitive interactivity. The multi-choice Q&A weekly revision acts like the course revision (see Pg.159 - Fig.90).
- The system also provides a link to the Project Details document. This enables a student to read in depth what saying 'Yes' entails.

The Communication Preference (CP) question/answer screen opens (see Pg.163 - Fig.94). He reads through it and sees that it seems to be quite easy to complete. It takes him about five minutes to make his selections, then he clicks the submit button. A brief report tells him that he is visual; he knew that already. He now clicks the Learning Styles button and reads the new screen and clicks to open the questionnaire.

- Communication Preference is designed to be easy to read and provides seven questions for each of the three types (visual, auditory, kinaesthetic). If a minimum of seven questions is not answered the system reports an error and returns the user to the original screen. After completion the system's algorithms assess the submission and return a value of V, A or K weighted in that order in the case of equality.

The Learning Styles questionnaire opens (see Pg.165 - Fig.96) and Adrian reads the instructions – simple he thinks. Then he starts to read the couplets. He notes that they are colour coded and soon finds that making a choice is not a simple as it appeared at first. Sometimes he would rather have more selections, it is hard to choose between one answer and another. Finally after about five minutes he completes his selection and submits his answers. An error screen opens telling his that he has missed one section (see Pg.165 - Fig.97). He notes that he missed two entries in the light blue section, Information Processing. He returns, makes his selection and once again submits his answers.

The Learning Styles Report screen opens (see Pg.126 - Fig.57, and Pg.166 & Pg.167 - Fig.98 & Fig.99); it has a lot of information. He saves it as suggested so that he can go over it again, and then reads it. He makes a comment to his friend that the report is uncannily accurate – he does not understand how a machine can understand him so well. He is particularly interested in the study advice and the section on Jungian Functions.

- The Learning Styles screen opens with statements. The systems algorithms output NLP Language Pattern that match the CP as ascertained from the CP answers. Thus the iconic student will see statements using visual text, the echoic will see auditory text and the kinaesthetic will see feelings text. When shown the difference between the scripts most students said that they preferred the text that matched their CP.
- The LS report is compiled by the system's algorithms and is unique to the student. It reports on his selection in each section of the questionnaire (Inter-personal Communication, Information Processing, Information Evaluation and Decision Style). Thus each section contains five statements out of ten. The total LS report contains twenty mixed statements out of forty directly linked to each individual answer.
- The LS styles report is compiled by the system's algorithms and is specific to anyone of the sixteen learning styles. Each of the four couplets are reported on individually and incorporated in the overall statement. As stated in the report, where a student is in the middle (e.g. E=3 – I=2 or E=2 – I=3), he/she can easily move from one learning style to another. The system allows a student to control

output by using the Change Feedback response facility (see Pg.129 - Fig.60 & Fig.61). The LS Jungian Functions report is compiled by the system's algorithms and is specific to anyone of the sixteen learning styles.

He clicks the link to enter his answers into the database (his full Student Profile is saved in the Student Profile Repository) and module selection screen now opens. Once again Adrian enters his Student ID and password and the module front page opens (see Pg.141 - Fig.70). This time his full co-ordinates are used and passed to the selected module front page.

- Part of the system's requirements is to maintain integrity of the databases. The system deleted all session variables at the end of the psychometric tests and now needs to reinstate them. The student is only asked to go through these tests once, thereafter, the system checks and finds that the student is logged as an existing user.

Adrian notes that WISDeM offers the normal online learning DLT facilities. Now he uses the tutorial facilities by opening the Main Topics page (see Pg.113 - Fig.49) and clicking the links for his first topic.

7.4 Revision - Topic Learning

His tutor has advised the class to cover the material provided by Main Topics (lecture notes, lecture slides, etc) and then revise in-depth by using the Revision link. Adrian opens the multi-choice Question/Answer "Revision". He sees that this facility offers either weekly[56] or course[57] revision, he opts to open Topic Revision (see Pg.124 - Fig.55). He notes that there are two methods of revising using multi-choice Topic Revision, either as a **learning**[58] tool or a **testing**[59]: he reads the information and decides to open topic learning.

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[56] **Topic Revision** allows you to either LEARN or TEST knowledge for any one or a series of lectures as the module develops offering: analysis, bibliographical sources, correct answers, feedback, help, restart topic or revision and running totals.
[57] **Course Revision** picks a random multi-choice question from the whole module. This section is likely to be more useful towards the end of the module. Whilst it provides the functionality of the Topic Revision it DOES NOT provide feedback and therefore provides a good test of retained knowledge.
[58] **Topic Learning** provides information for each module topic allowing you to develop your knowledge - it covers: Q&As for each topic - select any topic's Q&As - see the relevant Bibliography - select next question - Each answer gives feedback indicating the reason why it is correct or incorrect.

He experiments with 'Topic Learning' and finds that he can open any topic using the hyperlinks at the top of the table - each topic opens with the first question with three answers.

- The system's algorithms allow a student to select any topic for revision. These can be opened using a hyperlink in the topics learning screen or using the facility in the 'Main Topics' screen. When the latter is used the first question of the chosen topic is opened.

He goes back to Topic 1 Question 1 and reads the header message. He now reads the question and clicks the bibliography link ( ) to check if he has the correct reading material for in-depth learning (see Pg.189 - Fig.113), he likes the way each answer is expanded with feedback providing him with information about the answer: why it is incorrect or correct, he notes that the colour coding allows him to easily understand the various parts of the page (see Pg.125 - Fig.56). He clicks the next question button and reads this question. Here he sees that there is a link to a diagram, he clicks the link ( ) and remembers that it was used in his lecture (see Pg.116 - Fig.51).

- The bibliography link ( ) appears for every question and provides students with all references used to create the question and its answers and feedback.

- The iconic link ( ) is only output by the system where the algorithms detect that such a link exists. The student sees a diagram, picture or video relevant to the question, answers or feedback.

Adrian continues to use Topic Learning until he has reached the end of the questions and answers (twenty are provided per topic). He notices that the header message stays the same and that the green text over each question and answer changes and that the brown text over each section of answer feedback changes but provides similar information to previous pages, he ignores these messages.

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[59] **Topic Testing** allows you to test your retained knowledge - it provides: Running % total (carried forward) - Q&As for each topic - see relevant Bibliography - see the correct answer - restart your current Topic (Q1) - restart your revision (Topic1,Q1) - select next question - see any topic correct Answers - view your Analysis report - your progress is saved - you start where you last stopped.

- The system's use of repetitive messages means that the student notices the fact and skips over the information, his 'have I seen something like it before' filter kicks in leading to conscious rejection (see Fig.137); however, here is where subliminal text messaging starts to work (Catania, 1992; Gustavsson, 1994) (see Pg.61 – Iconic memory) and where the NLP Language Patterns matching his Communication Preference is effective (see 3.2.2 Pg.64 - NLP - Language Patterns). His eyes scan the page, take in the displayed information at the subliminal level, and he consciously notices what he wants to see.

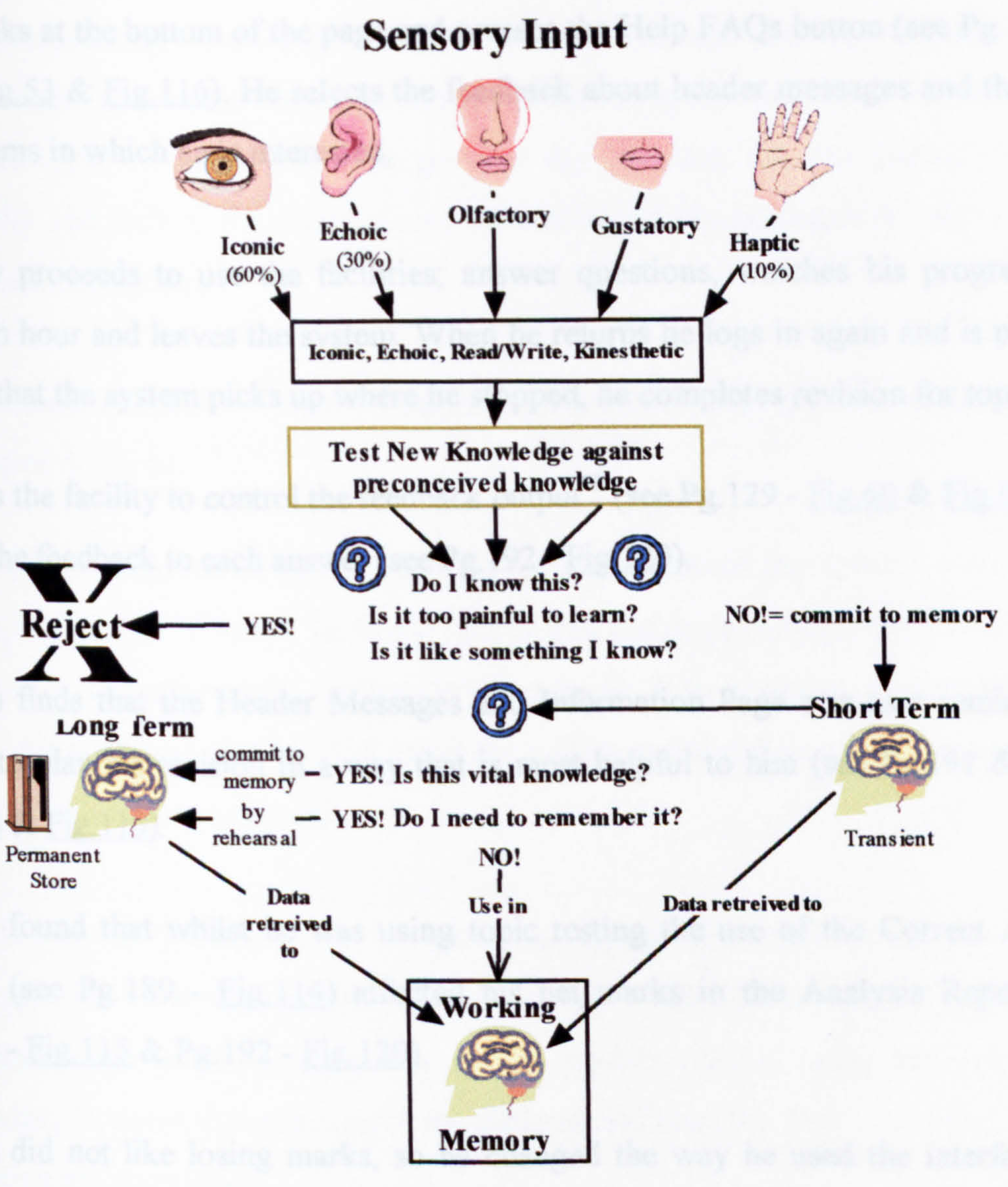

Figure 137 - Memory Input and Output Processing

7.5 Revision - Topic Testing

Adrian is now ready to open topic testing to see how well he has remembered the material. He looks at the page and notes a few differences, there is a module gross running mark (what does that mean?) and some additional link buttons (see Pg.127 - Fig.58 & Pg.180 - Fig.106). He decides to learn about the facilities this page offers and clicks the link button () (see Pg.188 - Fig.111 & - Fig.112).

This provides him with information about the buttons on this page currently showing and some on links not shown. He now answers question one and submits the answer: this adds information to his screen (see Pg.180 & 181 - Fig.107 & Fig.108).

He reads the feedback and notes that his selected answer was correct. He notices some more links at the bottom of the page and presses the Help FAQs button (see Pg.123 & 190 - Fig.53 & Fig.116). He selects the feedback about header messages and then the other items in which he is interested.

He now proceeds to use the facilities; answer questions, watches his progress for about an hour and leaves the system. When he returns he logs in again and is pleased to note that the system picks up where he stopped, he completes revision for topic 1.

He likes the facility to control the feedback output[60] (see Pg.129 - Fig.60 & Fig.61) and see all the feedback to each answer (see Pg.192 - Fig.120).

He also finds that the Header Messages and Information Page acts as a reminder to enable to plan his revision in a way that is most helpful to him (see Pg.191 & 192 - Fig.118 & Fig.119).

Adrian found that whilst he was using topic testing the use of the Correct Answer Button (see Pg.189 - Fig.114) affected his net marks in the Analysis Report (see Pg.190 - Fig.115 & Pg.192 - Fig.120).

Adrian did not like losing marks, so he changed the way he used the interface. He used the 'Revision Question Answers' at the bottom of the page where he could enter a topic number - see all the questions (see Pg.191 - Fig.117) for that topic and select a specific question answer.

[60] In the evaluation interviews students who used this facility said that it was well appreciated. They liked the concept of being able to control what the system produced.

Whilst the answer was provided he had to match this with the answer on the question screen (see Pg.193 - Fig.122).

- **Memory Rehearsal** – The scenario, where Adrian is using the system's Topic Learning and Topic Testing, is encouraging him into memory rehearsal. He does not like loosing marks, so he tries not to use the Correct Answer Button. Instead he uses the facility to see all questions and select a specific question and see the answer. He then has to compare this with the answers provided.

  When observing the students using the system they said that they did not like to lose marks and would rather get round this by using the other facilities, returning to the topic learning section to go over the revision, use the question/answer facility and look at the slides. Some elected to use the bibliography and look up the referred section.

  The actual evaluation results showed that after initial using the CAB most students stopped doing so.

Following his lecture on Topic 2 Adrian once again opened the Topic Learning and then Topic Testing; however, he found that he had not done enough revision and used the 'Restart Topic/Revision' button to reset topic 2 to question 1 (see Pg.127 - Fig.59). Adrian found that he liked using the system and that he was able to remember and recall information very well.

Towards the end of the semester he opens the 'Course Revision' to test his retained knowledge. He finds that, whilst the facilities are similar to Topic Testing, the way the questions are asked randomly from all the module's topics really test his retained knowledge, he notes that some parts are difficult and uses the Topic Learning facility to improve his knowledge.

7.6 Revision Q&A Page facilities & Student Model status update.

The Revision Q&A page interacts with the database where all answers are logged and the student's knowledge state is updated in his/her Student Profile repository. All output is governed by the student's current Student Model status[61]: output varies both in quantity and content. The page provides:

- *Module Gross Running Total%* - this shows the current % level for all questions answered for ALL sessions. The system stores answered question results in the Student Profile repository and thus allows the student to pick up where the last session stopped.
- *Information button*  - provides a link to a page that covers the buttons and links offered in the page.
- *Header Messages* - This box provides information, guidance and statistical information - for some users.
- *Bibliography Button* - This button opens the relevant Bibliography for the question asked (hyperlinks, lecture notes slides, books with page source). Where relevant this contains a link to the relevant diagram upon which the question and answers are based. This allows the student to research to a greater depth if required.
- *Feedback* - Feedback is provided for each answer selected. This provides guidance and extra information pertinent to the question asked and the multi-choice answer selected. Some Learning Styles have information provided for each answer with the selected answer indicated.
- *Diagram Button*  - This button is displayed at the end of the feedback line. It allows the student to open the relevant diagram upon which the question and answers are based.
- *Change Feedback Response* - This opens a page that allows the student to change the amount of and type of feedback being received.
- *Header Messages hyperlink* - This opens a page that displays all Header Messages - guidance and information output specifically for the student using the system.
- *Answers Feedback hyperlink* - This link opens a page that displays the Question and each Answer with feedback for each answer.
- *Statistical Feedback hyperlink* - This opens a window that provides statistical details of all questions answered - it reports on the student's module progress and progress for each of the topics attempted so far.

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61 **Student Model status** is changed dynamically as each question is answered and/or a new topic is started. Whilst the student can change the output he/she sees, the system maintains this Student Model status: the student can revert to the original output at any time.

- *Submit Answer button* - Stores data. Displays: Running Total % and 'Correct answer' or 'Incorrect answer' with relevant feedback - the student can only answer a question ONCE.
- *Correct Answer button (CAB)* - Opens a small window displaying the correct answer - it also stores the fact that this button has been used - this affects the student's true running total: his/her CAB mark.
- *Restart Topic / Revision button* - Opens a page that allows the student to clear either the current topic answers from the database or clear all data held for all previous answers: the former resets to Topic=current, Question=1, Mark=readjusted, the latter resets to Topic=1, Question=1, Mark=0. This allows the student to re-run his/her revision from 'scratch' (current topic or whole revision) and retake the test until he/she is satisfied with memory retention. An important feature built into the system is that the current Student Model status is stored when a reset is used. Thus the tutor has the facility to observe each individual student's progress.
- *Next Question button* - Displays the next question in the current topic or the first question in the next topic or outputs a page telling the student that there are no more questions.
- *Analysis Report button* - opens a page offering a full analysis of the student's progress showing which answers were correct and which were incorrect. The latter offers the facility to view the correct answer.
- *Help & FAQ button* - Help FAQs covers the use of both types of Revision (Week & Course) and for the Tutorial Questions by listing Frequently Asked Questions. These are included following feedback from students.
- *Revision Question Answers section* - This allows the student to enter any topic number. This opens a page that shows all the questions for the current topic and allows the student to select and see the correct answer.

In addition to these specific page facilities, the student has the facility to use the generic Forum, Search and Help links in the page top header bar and the left menu button, including a Feedback facility.

7.7 Chapter Summary

This chapter provides a scenario of a composite student drawn from the evaluation of the system and the feedback provided concerning the students' use of the system and raised the following points:

- The majority of students used the interactive route and some, who had initially logged in quickly without going through the psychometric tests asked to be able to start again. They noted that they did not have the functionality provided by the intuitive interactive system.
- They found the Communication Preference easy to use; a few did see the error message and quickly coped with their error. The resulting V, A, or K was well received and they found that the systems was seamless.
- The Learning Styles questionnaire uses statements that match the student's CP thus the iconic student will see statements using visual text, the echoic will see auditory text and the kinaesthetic will see feelings text. When shown the difference between the scripts many students said that they preferred the text that matched their CP.
- The unique LS report, compiled by the system's algorithms, was well received and discussed. As stated in the report, where a student is in the middle (e.g. E=3 – I=2 or E=2 – I=3) he/she can easily move from one learning style to another; however, the system allows a student to control output.
- The LS Jungian Functions report is compiled by the system's algorithms and is specific to anyone of the sixteen learning styles.
- The system's algorithms allow a student to select any topic for revision.
- The system's use of repetitive messages means that the student notices the fact and skips over the information. His eyes scan the page; take in the displayed information at the subliminal level, and consciously notices what he wants to see.
- Memory Rehearsal is encouraged by the system. Students do not losing marks and tried to find an easy way around it: this entailed more time looking at the material – more memory rehearsal.

CHAPTER 8

EVALUATION

8 Evaluation

This chapter looks at:

- Usability Evaluation
- Planning the evaluation
- Execution of the evaluation
- Evaluation results
- Chapter Summary

8.1 Introduction

This chapter first defines 'usability evaluation', introduces the concepts of *effectiveness, efficiency and satisfaction* as outlined in the International Organization for Standardization (ISO) 9241[62]. This leads on to a discussion of planning WISDeM's evaluation and covers the research hypothesis and evaluation objectives. It also expands on what needs to be evaluated and the requirements of the Ethics Committee clearance to execute an evaluation using students. The chapter then reports on the fine details of the evaluation that was designed to test the validity of the hypothesis and to allow the required statistical analysis to either support or reject the hypothesis. The evaluation evidence covers the anecdotal evidence, the subjective evidence and the statistical results with relevant conclusions being drawn from each. Finally the summary outlines the significant findings of the exercise: the support of the hypothesis.

This evaluation was a systematic and objective examination of the completed project. It aimed to answer specific questions and to judge the overall value of the system, to provided information in order to improve it. To execute this evaluation it was first necessary to decide which evaluation methods were to be used and then how to conduct it. The sections 'Usability Evaluation' and 'Planning the Evaluation' provided the information that was required to make the decisions required.

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[62] ISO - produces many standards related to usability of which this standard, "Ergonomics Requirements for Office Work and Visual Display Terminals" covering displays, keyboards, menus, work environment, etc., is both lengthy and widely read (Shneiderman & Plaisant, 2005).

8.2 Usability Evaluation

Usability[63] Evaluation is "*A concept comprising the effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a particular environment*" (ISO, 1998)[64].

Usability Evaluations commonly seek to determine the efficiency, effectiveness, impact, sustainability and the relevance of a project or organization's objectives. They should provide information that is credible and useful, offering concrete lessons learned to help make decisions.

- **Effective**: achieve the required goals with accuracy and completeness; in practice the evaluation needs to break the goals into sub-tasks whereby each task can be measured and thus the whole subjectively measured, notwithstanding possible failure, to achieve a required result.
- **Efficient**: operate quickly and effectively in an organized way so as to finish the task in the least possible time using as little effort as possible taking into consideration the accuracy and completeness of the tasks allowing for the resources expended; in practice the evaluation should look at sub-tasks to enable consideration of partial completeness and know what is required for the achievement of effectiveness (a subjective idea for each evaluator).
- **Satisfy**: fulfill or gratify a requirement, be comfortable and acceptable to the user; in practice measuring a user's comfortableness and acceptability means measuring each users own subjective ideas - the larger the sample the more the mean is likely to provide accurate measurement. Essential to usability evaluation are definitive objectives and success criteria using precise metrics that enable the evaluator to make meaningful inference from the evaluation.

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[63] **Usability**: the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (Shneiderman & Plaisant, 2005).

[64] **ISO 1998** - ISO 9241-11: Guidance on Usability (1998)
This standard (which is part of the ISO 9241 series) provides the definition of usability that is used in subsequent related ergonomic standards: ISO 9241-11 explains how to identify the information that it is necessary to take into account when specifying or evaluating usability in terms of measures of user performance and satisfaction. Guidance is given on how to describe the context of use of the product and the measures of usability in an explicit way. It includes an explanation of how the usability of a product can be specified and evaluated as part of a quality system, for example one that conforms to ISO 9001. It also explains how measures of user performance and satisfaction can be used to measure how any component of a work system affects the quality of the whole work system in use (ISO, 1998).

In addition evaluation should address the following:

- **Learnability**: how easy does a new student find the system to use and which parts of the system's functionality are in fact used; if it is difficult the student subjective measurement will be coloured, thus the intuitiveness of the interface is important.
- **Errors**: these can be categorized as:

  Minor - irritating, quickly spotted, <u>easy to rectify</u>, do not affect completion,

  Major - irritating, quickly spotted, <u>time consuming to rectify</u>, do not affect completion,

  Fatal - prevent the user from completing the task/s)

  Catastrophic - change the state of the system not allowing recovery
- **Remembering**: encourage retention of knowledge over a period of time (long-term memory),
- **Time-to-learn**: provide an instinctive interface that needs little time to learn how to use.
- **User satisfaction**: promote user satisfaction with the interface.

  (Faulkner, 2000).

8.2.1 Usability Evaluation methods

(Macaulay, 1995) provides a useful listing of different types of evaluation including:

- *Analytical Evaluation* uses either a formal or semi-formal model to describe or predict user performance.
- *Expert Evaluation* requires an expert in the system being evaluated to carry out the evaluation.
- *Experimental Evaluation* uses scientific experimental practice to test the hypothesis/es about the user interface.
- *Observational Evaluation* involves watching the user and recording the required information whilst the user uses the interface.
- *Survey Evaluation* uses questionnaire and/or interview techniques to discover subjective information both from the user and about the user's interaction with the system.
- *Feature Checklist Evaluation* uses a checklist to identify which features are used by the user and, in some instance, the number of times the feature is used.
- *Incident Diary Evaluation* uses structured forms on which the user or evaluator can record incidents whilst the evaluation is being executed.

- *Co-operative Evaluation* uses feedback from users about good/bad points and/or problems encountered by the users working with a prototype.
- *Focus Group Evaluation* uses the interaction between users using and discussing the interface. The evaluator records the interactions.

(Faulkner, 2000) discusses usability engineering including the above and:

- *Formative Evaluation* is used to refine and create the design and works closely with the user/s obtaining feedback and opinions.
- *Summative Evaluation* asses the impact, usability and effectiveness of the system
- *Empirical Evaluation* analyses user performance in relation to the system.
- *Design Heuristic Evaluation* tests the conformance of the interface against a set of predefined guidelines.
- *Cognitive Walkthrough Evaluation* requires an expert to go through a task or tasks. It requires the expert to be able to act as a pseudo-user with all the knowledge that the user is likely to posses and ignore knowledge of the system that the expert may have that the user is unlikely to possess.

There are advantages to all usability evaluation techniques, at the:

Design stage:

- *Brainstorming*: is the act of defining a problem or idea and coming up with anything related to the topic - no matter how remote a suggestion may sound. All of these ideas are recorded and evaluated only after the brainstorming is completed.
- *Observation*: of the current work practice,
- *Storyboarding*: is a pencil and paper technique for designing and testing user interfaces. Although it is not as immediate as a prototype, it has the advantage that it can be done without a computer. Thus it is available for use by non-programmers. It shows the sequence of events, specifying the user actions that cause them.
- *Wizard of Oz*: is a method of testing a system before it is built with the user interacting with the wizard (a person who simulates the system's proposed functionality).

Early prototyping stage: Conformance to guidelines, Expert Walkthrough, Heuristic Evaluation and Small pilot study using, for example video or other methods.

Advance prototyping stage - usually in the user domain: Checklists, Controlled Experiments, Co-operative Evaluation, Focus Groups, Interviews, Questionnaires, Software Probes, Usability Metrics and Videoing, and

Delivery stage: Observation in the workplace.

8.2.2 Statistical requirements

The data collected in an evaluation needs to be analyzed to gain insight and draw conclusions that can be shown to be supporting either the hypothesis (H_a) promulgated as stated or not, the null hypothesis (H_o). Maximum integrity in sampling[65] can be achieved by using *simple random sampling* (sampling without replacement): this provides the probability that any respondent can participate without any preference and therefore the sample is more likely to reflect the whole rather than if any other sampling method is used (Clarke & Cooke, 1978; Thompson, 1992; Yates et al., 2002).

Where the evaluation requires to tests *control* and *interactive* results statistical analysis requires to '*compare two means*'. The importance of the selection of sample is paramount, stronger results are obtained where each group is matched: thus the subjects need to be selected from respondents who have the same dynamics. Another factor considered was the fact that the (two) anticipated sampling sizes were unequal. The relevant statistical tests for these parameters are ANOVA[66] and Two-Sample T-test[67].

8.3 Planning the Evaluation

During the design stage a 'Wizard of Oz'[68] approach was adopted and the potential requirements developed using 'Cooperative Evaluation'. At the inception of the implementation, 'Cognitive Walkthrough Evaluation' and 'Brainstorming' were adopted. For example it was realized that, whilst database linking was achieved using a structured query language compatible with Microsoft's Access, for scalability it would be necessary to change this to an SQL database ODBC linking: some thirty-plus pages were tested for compatibility for this change with success.

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[65] **Sampling** – "*Simple random sampling is the sampling design in which n distinct units are selected from N units in the population in such a way that every possible combination of the n units is equally likely to be the sample selected.*" (Thompson, 1992)

[66] **ANOVA** – Analysis of Variance compares the variation due to specific sources with the variation among individuals that are similar (Yates et al., 2002).

[67] **Two-Sample T-test** - is a hypothesis test for answering questions about the mean where the data are collected from two random samples of independent observations, each from an underlying normal distribution (Yates et al., 2002).

[68] The author being the Wizard

As the project developed, Observational, Survey and Interview Evaluations were used to test sections of development with computer literate and non-literate subjects: Feedback was noted and incorporated into the design that was revised on an iterative development approach.

At all stages the tenet of 'Force Field Analysis'(Lewin, 1946) was used. *Force Field Analysis* is a method used to get a whole view of all the forces for or against some development.

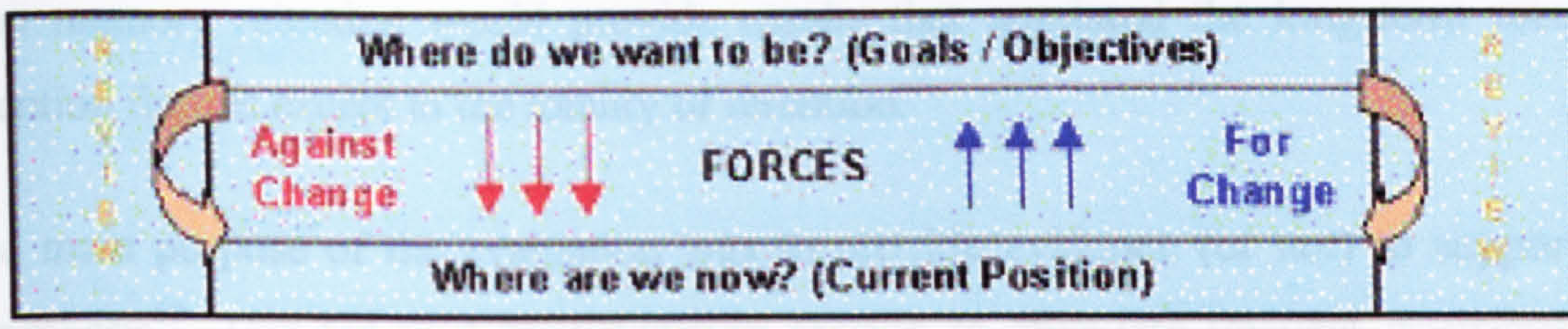

Figure 138 - Force Field Analysis. This diagram shows Force Field Analysis components and the flow between these components.

It helps to identify probable prioritized effective changes using the following steps:

☐ *Describe Goals*	Where do we want to be (Goals / Objectives)
☐ *Describe position*	Where are we now (Current Position)
☐ *List all forces*	two columns (for change | against change)
☐ *Score each force*	for likely effectiveness (1 weak to 5 strong)
☐ *Draw Force Field Analysis diagram*	show scaled forces for and against
☐ *Analyze forces*	in particular look for hidden agenda which will negate action
☐ *Prioritize change*	list in practical change order

Once the prototype was sufficiently well developed to present to users, a definitive formal evaluation study was developed using 'Cognitive Walkthrough Evaluation'. This provided the answers to: what methods should be used and why?

☐ *What methods?*	Personal Observation, Questionnaire, and Interview.
☐ *Why?*	Keyboard keystrokes to quantify screen facility usage, Likert scales to quantify subjective feedback and User feedback to obtain personal user feelings.

(Catania, 1992) reports that the percentage recall of instances after forty-eight hours is almost identical to that recalled after one month thus evaluation should take cognizance of this fact. Ideally two groups of students were required, a **control group** (CG) with an interface that exhibits no Student Modelling and non-intuitive interaction and an **interactive group** (IG) with a Student Model affected by an intuitive interactive interface. The results of both students in their examination at the end of the semester should be compared and evaluated.

Could this process be realistically truncated? It was decided that it could. The assumption was made that using both groups over a short period of time to test short-term memory retention would provide results that emulated the long-term memory retention figures except in the totality of retention.

The main purpose of the evaluation was to provide evidence (or not) to support the hypothesis[69]. This led to a brainstorming session to elucidate relevant questions and formulating a design. The top sub-questions were: *What needs to be evaluated? - What methods need to be employed to achieve these objectives?* From this the evaluation objectives were formulated.

8.3.1 Evaluation objectives

Each usability objective MUST have associated success criteria that are capable of measurement, for instance:

- How well the system works?
- Time taken to perform a task.
- Number of keystrokes for a task.
- Does the user use the system as planned?
- Is the interface intuitive to use?
- Does the interface adapt to the user's needs and requirements?

The evaluation study required subjects and facilities with the following criteria:

- Users with required experience level.
- Tasks to be executed and both understanding and comprehension of the proposed tasks.

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[69] **Research hypothesises** - "*Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning*".

- Facility to connect to the WISDeM system.
- Correct environment for the evaluation to be executed and all ergonomic factors needed to be able to carry out the tasks.
- Facilities for the evaluation (e.g. Evaluators, evaluation forms)

The evaluation objectives were

- To provide evidence (or not) to support the hypothesis.
- To ascertain the effectiveness OR potential effectiveness of an interface. To be effective the system needed to demonstrate that students' remembering - learning and recall of instances of knowledge - was measurably improved by the system.
- To provide a means for discovering potential improvements and suggesting where improvements can be made. To practically assess learner reaction to a prototype development that uses the learner's own CP and LS.
- To collate data that measures the learner's ability to learn and recall facts using a control non-interactive tutorial system and an interactive tutorial system: the latter using the Student Profile.
- To provide sufficient data to enable a definitive comparison to be made.

8.3.2 What needs to be evaluated

The following outlines what needed to be evaluated and created further criteria for the evaluation design and content:

- *WISDeM assess Communication Preference and Learning Styles.*

  The way this is done, the report and the final results needs to be evaluated and compared with the student's expectation and psyche.
- *Comparative definitive measurement of memory retention is required for the control interactive groups.*

  It is necessary to design into the evaluation the results of memory retention for the two groups so that they can be metrically compared.
- *Memory retention is affected mainly by rehearsal of an instance of knowledge.*

  It is necessary to measure the amount of memory rehearsal the student employs when using the system and compare both groups.
- *Memory rehearsal requires the student to be attracted by the process of learning, a subjective subject that also required attention.* Attracted by what? ...The interface,

the knowledge content, the interface interaction, the feedback, the motivational content, the facilities?

It is necessary to assess subjective student reaction to the whole experience: some by predefined enquiry and some by interview, the latter to cover ideas that escaped the Cognitive Walkthrough Brainstorming.

The basic tenant for the whole evaluation was that viable/replicable criteria and metrics needed to be designed into the evaluation in order to create valid results. Viable so that the evaluation was feasible at all times and replicable so that future evaluations or assessments are capable of being executed and compared with these first results.

To be able to extrapolate and evaluate data having some basic data about each subject was considered necessary.

8.3.3 Ethics clearance

Before any evaluation can take place, it is necessary to obtain the consent of the LJU's Ethics Committee: *The LJMU Ethics Committee and the British Psychological Society require that valid consent of the participants should have been obtained having taken all reasonable steps to ensure that they have adequately understood the nature of the investigation and any anticipated consequences.*

Once the evaluation and use of students was approved the full questionnaires were designed to be run for either one session of circa two hours or over two sessions as required: essentially both sets of report forms ask the same questions. These provide the full details of the questions and approach to the evaluation.

8.3.4 Success Criteria – Design and Rationale

'Observation in the workplace' evaluation was used due to the fact that it tends to deliver accurate and natural data for evaluating most delivery systems, in addition questionnaires and interviews were included, the former providing reports on pre-planned evaluation objectives and the latter covering the greater depth required for a rounded evaluation by being able to expand on subjective feelings and feedback that was not foreseen.

The evaluator can use either DIRECT or INDIRECT OBSERVATION:

- 'Direct Observation' requires physical presence and a well designed checklist/interview questionnaire to look for specific criteria during observation and after observation; however, the very presence of the evaluator often creates the Hawthorn Effect [70] and no permanent visual data is available; conversely the interaction between the evaluator and the subject often provides invaluable insight into the system-user interaction and feelings that may well not be observed in a video recording.
- 'Indirect Observation' utilizes recording methods such as videoing and computer logging and can provide more detailed data, the permanent visual record can be played back and it tends to reduce the Hawthorn Effect; however, it can be very time consuming to analyze and more expensive (the equipment can break down!!).

To ensure the maximum integrity in sampling *simple random sampling* (sampling without replacement)[71] was used. It was anticipated that the sample sizes would be unequal because the test was to be run in two sections requiring circa two hours in total; risk factor analysis suggested that some students would complete only one part of the evaluation: thus ANOVA and Two-Sample T-test were used to produce the statistical analysis report.

8.3.5 The design of the experiment

In WISDeM, Direct Observation required the creation of two groups, the Interactive Group (IG) identified with even and the Control Group (CG) identified with odd evaluation reference numbers. The experiment required to extract comparative information on the use of BOTH types of interface; thus, both groups needed to experience both types of interface interaction (see Fig.139). The IG used the interactive interface first and then the non-interactive interface and the CG used the non-interactive interface and then the interactive interface. In this way each group experienced both interface types; and, comparative results were compiled that allowed definitive evaluation of the experiences of both groups.

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[70] **Hawthorne Effect** - The user is aware that his/her operations are being observed and performance measured and may show more care than normal in executing his/her work and/or may experience embarrassment and make unusual mistakes - the work may not well equate to normal. (Available at http://software.isixsigma.com/dictionary/Hawthorn_Effect-557.htm (November, 2003))

[71] **Simple Random Sampling**: each number was allocated sequentially (odd then even) to the next student without any type of selection or replacement; thus allocation of numbers was completely at random.

8.3.5.1 The Interactive Group experiment

Interactive Group (IG) students experienced the following - Fig.139 (Interactive and Control Group flow charts):

- *Students log in using their IG identity and complete the psychometric tests.* During the first test their Communication Preference is established and from this their Neurolinguistic Programming language pattern ascertained as requiring Visual, Auditory or Kinaesthetic textual messages. The second test is output using their personal language pattern. After the student has read and confirmed their report on the outcome of their selected answers, the results of the two psychometric tests are collated and permantly stored in the 'initial profile' database table.

  See Fig.94 – Communication Preference Screen – this shows the screen that the students see for the first psychometric test that indicates their Communication Preference.

  See Fig.96 – Learning Styles Screen – this shows the screen that the students see for the second psychometric test that indicates their personality type learning styles (one out of a possible sixteen made up from the couplets E|I, S|N, T|F and J|P[72]).

  See Fig.57 – Learning Styles – report Part 1, Fig.98 – Learning Styles – report Part 2 and Fig.99 – Learning Styles – report Part 3 for a sample of an individualized report that is produced for each student to read before agreeing to proceed.

- *Enter Topic 1; use the IG Topic Learning section for all 20 questions using any links considered necessary to aid learning.*

  Here the student sees a screen that provides additional information to that seen by the CG screen. Each message cell contains text messages drawn from the database that are relevant to the student's profile (i.e. the output is different for each student being governed by their individual Communication Preference and Learning Styles)

  1. The 'Header Message' cell not only shows the title of the topic being revised but also shows relevant supportive and informative script.

[72] Extrovert|Introvert, Sensing|iNtuition, Thinking|Feeling and Judgement|Perception

2. The question cell has a random highlighted 'header line', drawn from the database, using a Neurolinguistic Programming (NLP) language pattern message: individualized for each student.
3. Each answer cell (there are three) also has a random highlighted 'header line', drawn from the database, using an NLP language pattern message: individualized for each student.
4. Each answer feedback cell (one for each answer) also has a random highlighted 'header line', drawn from the database, using an NLP language pattern message: individualized for each student.

(See Fig.56 – Revision – Topics Learning Section. This figure shows the Topics Learning screen and the way that it is colour coded to enable the student to identify the different types of messages and information as each question, answer and feedback changes.)

- *Open IG Topic Testing; complete all 20 Q&A using any links considered necessary to complete their task.*
    1. Here the IG student sees a screen very similar to that seen in topic learning; however, as this is topic testing, answer feedback cells are not output. Each of the other cells outputs individualized random script pertaining to the student's profile. As for the CG student the IG student also sees the 'Module Gross Running Total': this is set to either zero the first time the module test is run, or set to the score attained so far, where answers have already been posted for this module.
    (See Fig.105 – Topic Testing Pt1 showing header message – Fig.106 – Revision – Topic Testing – Pt2 for the output for this stage)
    2. Once the student has submitted a selected answer the page changes. The IG student sees a new header message section that provides a variety of specific feedback on his/her progress so far through the test (see Fig.107 – Topic Testing – Feedback – Pt1, Fig.108 – Topic Testing – Feedback – Pt2). This feedback is directly linked to his/her communication preference and dynamically changing profile with script being drawn from the database according to the various learning style and novice|expert factor weightings (see Fig.101 – The rfFactor, mqFactor, NEfactor feedback types and Fig.102 – Factor creation). Thus this feedback/advice changes dynamically as the student progresses through

the topic: the NEfactor is returned to its default value as soon as a new topic starts)

The student also sees relevant feedback for the selected answer; however, for the IG student this feedback has a relevant header message. In some instances, as defined by the algorithms, EVERY answer can have feedback and header messages output: this is governed by the dynamically changing student profile.

The IG student also has extra hyperlink facilities in the bottom cell ('Change Feedback Response', 'Header Messages', 'Answers Feedback' and 'Statistical Report') that the CG student does not see. The following screen shots cover these:

Fig.60 – Change Feedback response – Pt1

Fig.61 – Change Feedback response – Pt2

Fig.118 – Header Messages – Pt1

Fig.119 – Header Messages – Pt2

Fig.120 – Answer Feedback page

Fig.121 – Statistical Feedback.

- *Exit to WISDeM front page.*
- *Log in again using their CG identity and DO NOT complete the psychometric tests.*

  The description of this section is identical to the CG details below.
- *Open the CG Topic Testing section; complete all 20 Q&A using any links considered necessary to complete their task.*

  The description of this section is identical to the CG details below.

The IG students have immediate experience of the intuitive interactivity due to the fact that they have to complete the two psychometric tests (the LS questionnaire is couched in NLP language patterns that match their CP). The test reports provide them with feedback and, at the same time, let them know that the question and answer screens are going to be reacting to their specific CP and LS. This in itself is designed to raise their interest in using the system. When they log in again for the second time and use the CG system they immediate note the differences.

8.3.5.2 The Control Group experiment

Control Group (IG) students experienced the following - Fig.139 (Interactive and Control Group flow charts):

- *Log in using their CG identity and DO NOT complete the psychometric tests.*
  When the student first enters the module he/she is asked to select whether or not they wish to complete the two psychometric tests (see Fig.93 – Personal Communication Preference and Learning Styles Introduction page). On selection of the message "No, I wish to enter the module immediately without completing the questionnaires" the module front page is opened and the database records the fact that the student has elected not to have an intuitive interactive interface.
- *Enter Topic 1; use the CG Topic Learning section for all 20 questions using any links considered necessary to aid learning.*
  On entry the student see a similar screen as per 'Fig.56 – Revision – Topics Learning Section', **without** any of the header messages: thus the 'header message' cell only shows the name of the topic, the question cell only shows the question, the answer cell only shows the answer and the feedback cell only shows the feedback for its specific question.
- *Open CG Topic Testing; complete all 20 Q&A using any links considered necessary to complete their task.*
  1. On entry to topic testing the student sees a similar screen as per 'Fig.105 – Topic Testing Pt1 showing header message' – 'Fig.106 – Revision – Topic Testing – Pt2', **without** the header messages: thus the header cell containing the advice and information is **NOT** output, the question cell only shows the question and the answer cells only contain the answer. The page still contains the 'Module Gross Running Total' and all the link buttons shown in the figures
  2. When an answer is selected and submitted the feedback page opens as per Fig.107 – Topic Testing – Feedback – Pt1 and Fig.108 – Topic Testing – Feedback – Pt2, **without** the feedback header message cell or the header messages to the question, answer and feedback cells. In addition the hyperlink facilities in the bottom cell ('Change Feedback Response', 'Header Messages', 'Answers Feedback' and 'Statistical Report') are not output.

- *Exit to WISDeM front page.*
- *Log in again using their IG identity and complete the psychometric tests.*

  On entry the second time the student experience exactly the same as the IG described above.

- *Open the IG Topic Testing section; complete all 20 Q&A using any links considered necessary to complete their task.*

  Here the student experiences exactly the same as described for the IG student above.

The CG students log into the system and use the question and answer section without any expectancy of difference. Indeed, they reported that the system looks and feels very similar to other systems that they have used. When they log in for the second time they immediately notice the introduction to the intuitive interaction when they complete the two psychometric tests. Just like the IG students they reported that their expectancy and interest was raised, that their reaction to the system was more positive and that they experienced motivation not generated by the CG system (see evaluation report for details).

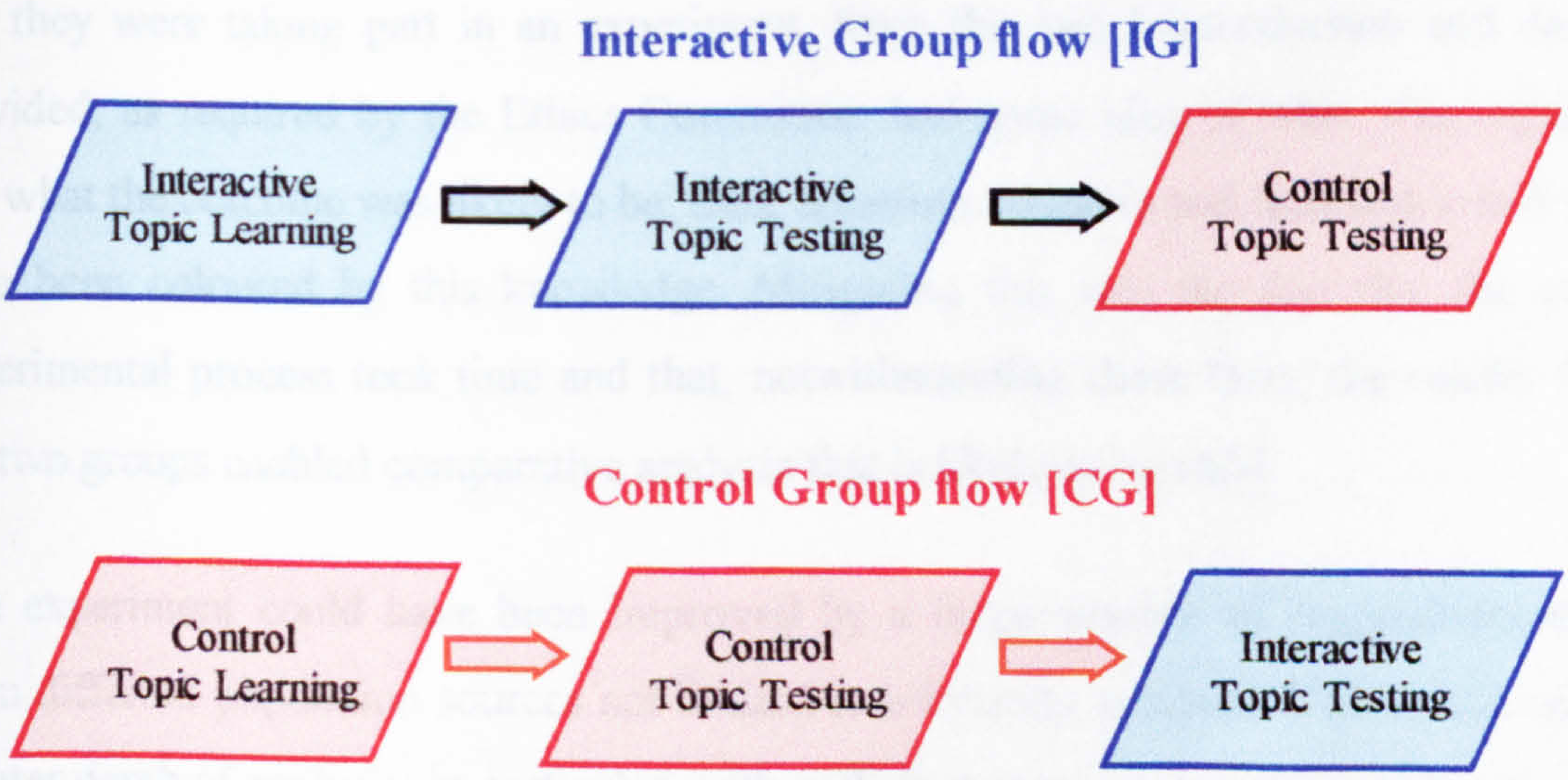

Figure 139 - Interactive Group flow & Control Group flow charts show how the two groups completed the evaluation exercise so as to ensure comparative analysis between both types of interfaces and comparison of the interface components for both types.

This modus operandi ensured that both sets of students experienced knowledge rehearsal and the different interfaces in a way that allowed for definitive comparative analysis.

8.3.5.3 The experiment concepts, problems and improvements

The concept for each approach is to allow a student to experience either the intuitive interactive interface (IG) first and then experience the non-intuitive interactive interface (CG) or vice-versa. This achieves four objectives for the forthcoming analysis:

1. It allows the student to experience both types of interface: this enables him/her to be able to make comparative assessment of the two types of interface and to provide subjective feedback.
2. It allows the evaluator to collect observational feedback, ask specific questions about the student's reactions to the two interfaces, to rate this subjective feedback and to make notes about the student's feelings concerning his/her experience: this information is used in the anecdotal and subjective analysis,
3. It allows the system to collect hard data for the statistical analysis.
4. It allows the gain in knowledge retention of one route to be compared with the other.

The underlying problems of the experiment, as designed, is that the sampling numbers were small and drawn from one discipline and year. In addition the respondents knew that they were taking part in an experiment, from the initial introduction and details provided, as required by the Ethics Committee, had some idea of what was expected and what the outcome was likely to be; thus, attention, answers and feedback could well have been coloured by this knowledge. Mitigating this was the fact that the entire experimental process took time and that, notwithstanding these facts, the results from the two groups enabled comparative analysis that is likely to be valid.

The experiment could have been improved by a large number of respondents taken from different population sources not limited to university subjects. This would enable greater depth of analysis: in particular, with sufficient respondents, it would be possible to isolate different parts of the system, personality type learning styles, communication preferences, differences between sexes, ages, educational backgrounds and jobs. However, this was not the underlying aim of the experiment, the underlying aim was to be able to establish if there was support (or not) for the hypothesis and, if so, to be able to highlight that this avenue of research probably required more development.

8.3.5.4 Success Criteria

It was anticipated that the IG route would:

- *Improve memory retention more than the CG route – higher comparative marks for the IG students to CG students equates to success.*
  1. Both routes are answering the same questions twice and therefore an improvement in marks is to be expected because the student has had memory rehearsal triggered by the second passage through the questions.
  2. The IG route has the advantages of an interface that changes the output for every student according to his/her profile (Communication Preference, Learning Styles and Novice/Expert factor). It also provides specific feedback based on his/her dynamically changing profile.
  3. Measuring the gain in knowledge retention for both routes and comparing the results would provide meaningful data. If the retention gain proved to be greater for the IG route than the CG route, then it would support the thesis hypothesis.
  4. The measurement of retention is reflected by the number of marks scored by each passage through the questions.
- *Increase the correct marks scored for the IG route than the CG route – higher comparative marks for the IG students to CG students equates to success.*
  1. The second run through the same questions is likely to increase the number of correct answers.
  2. It was anticipated that the increase for the IG route would be greater than the CG route.
- *Increase memory rehearsal more by using the IG route – greater use of facilities (links and buttons) equates to success.*
  1. Memory rehearsal is one of the keys to improving remembering.
  2. In the interface the use of the various facilities was observed and each button press/use of hyperlink from the Q&A pages was noted.
  3. It was anticipated that the use of these facilities would be greater by subjects using the IG interface: this increase use of the facilities equates to greater memory rehearsal. The comparison between the use of the IG interface and the CG interface was made.

- *Increase in enjoyment of and interest in using the system and therefore encouragement to learning – greater use of facilities (links and buttons) equates to success.*
    1. It was anticipated that the IG interface would have an effect on the enjoyment and interest in using the system.
    2. This would be evidenced by subjective feedback and time spent in memory rehearsal.

The IG students received Neurolinguistic Programme Language Pattern input, subliminal-text messaging (Catania, 1992; Gustavsson, 1994), and motivational and informative feedback, whereas the <u>CG students DID NOT</u>.

Each set of Q&A's was automatically marked and the marks retained in the database for later analysis. The cumulative gain of CG students was compared with that of the IG students.

- **The major evaluation criteria measurement for success was:**

  "If IG students demonstrate a larger gain in correct marks scored when answering the questions (in the Q&A facility) than the CG students, it would indicate that the IG system was likely to be assisting memory retention and recall (remembering) and be considered a successful outcome."

8.3.5.5 Design - Section 1 and Section 2

The definitive evaluation form was developed using:

Personal Observation to observe Keyboard keystrokes in order to quantify screen facility usage,

Questionnaire using Likert scales to quantify subjective feedback, and

Interviews to elucidate student feedback to obtain personal user feelings.

The evaluation was split into two sections: 1) Evaluate the logon and psychometric tests, and 2) Evaluate the intuitive interactive multi-choice Q&A system's performance and resulting affect on the participants.

SECTION 1: evaluate the Logon and Psychometric tests.

The logon required the student to report on the results from two psychometric tests.

1. The *first test* reports on the student's communication preference - the Visual | Auditory | Kinaesthetic test comprising some twenty-one statements with a

minimum requirement of seven to be selected. Once the student completes the VAK test, a report is produced informing the student of the results.

2. This leads to the *second test* that establishes the student's learning styles - this has five bi-polar questions per category (Interpersonal Communication: Extrovert | Introvert, Information Processing: Sensing | Intuition, Information Evaluation: Thinking | Feeling, and Decision Style: Judgment | Perception). Each question is couched in the student's own CP.

These two tests were combined to provide a CP and LS to which was added a Novice/Expert factor (NE) (Handley, 2002; William A. Janvier & Ghaoui, 2003b), thus establishing the initial Student Profile.

SECTION 2: Evaluate the intuitive interactive multi-choice Q&A system's performance and resulting affect on the participants.

This section offers some twenty questions to each modular topic:

- Each question has a bibliographical source and (if applicable) a link to a relevant diagram,
- Three answers to each question.

The multi-choice Q&A intuitive interactive algorithms output header messages, and a subliminal text message header (Catania, 1992; Gustavsson, 1994) to each Q&A: all headers change their content based on the dynamically changing student's profile. After an answer is submitted a header displays a selection of reward and progress information, and each answer is displayed again with either the corrected answer or further information for a correct answer. The quantity of information displayed is governed by the student's profile - the student has the facility to control this output if so required.

NOTE: In the following reports on the evaluation results:

i) All questions that are rated from 0=poor to 10=very good, to enable comparative data to be evaluated, ***are numbered*** in this report.

All questions that were completed by interview, where the answers to these provide additional information that cannot be necessarily predefined or planned, ***ARE NOT NUMBERED*** in this report.

8.3.5.6 *Design and Rationale - Questions CP & LS*

Part 1. Student Details - The first basis of any evaluation is to be able to extrapolate later further information; thus, the first section covered details of each subject:

Q1. *Enter FIRST registration reference*

This was required to identify which route the subject was taking.

Odd numbers = Control Group and even numbers = Interactive Group.

Q2. *What is your age?*

Enabled data to be extracted for age groups.

Q3. *What is your sex? (m|f)*

Enabled sex related data to be extrapolated.

Q4. *What degree course are you taking?*

Enabled level of experience and subject specialization to be related.

Q5. *What year are you in?*

Enabled level of experience to be related.

Q6. *Do you have any experience with computer multi-choice Q&As?*

Enabled familiarity level of experience to be related.

Questions 1 to 6 were designed to record the subjects' personal data and were used in the evaluation.

Part 2. Registration - Logon - Module Entry - covered each subject's feelings (CG or IG) after they had completed the Communication Preference test (or not) and was therefore completed after module entry was realized.

Q7. *Do you consider that registration was easy?*

Allowed comparative evaluation to be extrapolated and provided some indication of how well the system was received.

Is there any part that you consider could be improved?

This question allowed each subject to provide personal feedback and ideas for improvement.

Q8. *Do you consider that logon was easy?*

Allowed comparative evaluation to be extrapolated and provided some indication of how well the system was received.

Is there any part that you consider could be improved?

This question allowed each subject to provide personal feedback and ideas for improvement.

Q9. *Do you consider that Module Entry was easy?*

This question allowed comparative evaluation to be extrapolated and provided some indication of how well the system was received.

Is there any part that you consider could be improved?

This question allowed each subject to provide personal feedback and ideas for improvement.

Are there any other comments that you would like to make?

This question was designed to expand on the system and its use by the subject with ideas not specific to Q7 to Q9.

Questions 7 to 9 were designed to record the subjects' feelings about logging onto the system so that changes could be made if required: none were made.

Part 3. Communication Preference (CP) - asked the subject questions about their subjective feelings of the CP test, outcome and report:

Q10. *Do you consider that this CP matches your own ideas?*

This allowed the quality of the results to be quantified and compared

Q11. *Was this section easy to complete?*

This rated the feelings of each subject for definitive comparison.

Is there any part that you consider could be improved?

This allowed each subject to report on personal feelings specific to the completion of the CP part. It allowed the interviewer to explore specific avenues.

Are there any other comments that you would like to make?

This question allowed each subject to report on personal general feelings whilst also allowing the interviewer free reign to expand areas not previously specifically covered.

Questions 10 and 11 were designed to record the subjects' personal subjective feelings and to uncover any points not designed into the questionnaire. The results were reported and commented on in the evaluation results.

Part 4. Learning Styles (LS) - asked the subject questions about their subjective feelings of the LS test, outcome, report and use of their Neurolinguistic Programming Language Pattern as revealed by their CP:

Q12. *Do you consider that these LS match your own ideas?*

This allowed the quality of the results for LS to be quantified and compared.

Q13. *Was this section easy to complete?*

This rated the feelings of each subject for definitive comparison.

Q14. *Did the report adequately reflect your input?*

This allowed the subject to rate the quality of output against expectations and personal understanding of his/her psyche.

Q15. *Overall was the sequencing well presented?*

This rated the way the interface sequencing works.

Q16. *Overall did the Human Computer Interface act as expected?*

This rated the way the interface intuitiveness works.

Q17. *Overall was the use of colour and presentation up to HCI standards?*

This rated the use of colour and HCI principles - answers here needed to be compared with the subjects HCI experience: all subjects were attending HCI classes.

Is there any part that you consider could be improved?

This allowed each subject to report on personal feelings specific to the completion of Learning Styles. It allowed the interviewer to explore specific avenues.

Are there any other comments that you would like to make?

This question allowed each subject to report on personal general feelings whilst also allowing the interviewer free reign expand areas not previously specifically covered (e.g. To discuss and get feedback on the way the output uses NLP Language Patterns).

Questions 12 to 17 were designed to consider the subjects' feelings about their inTS experience (positive, negative or neutral). These feelings were discussed in the evaluation and hypothesis assessment.

8.3.5.7 Design and Rationale - Multi-choice Question & Answer

Part 5. Control Evaluation - during this part of the evaluation there was no interaction between the student and the evaluator: the less the interaction the greater the tendency for 'Hawthorne Effect' to be neutralized. The evaluator recorded the keystroke entries and at the same time entered comments in the 18 to 22-question-section; questions 18 to 22 were rated after keystrokes were scored.

Q18. *How intuitive did the student find the interaction?*

Rated observation by the evaluator.

Did the student find any problems using the WISDeM system?

Comments were made here when the student encountered any difficulties. This picked up any small design errors.

Q19. *Was understanding and comprehension demonstrated?*

Rated observation by the evaluator reporting on content design.

Q20. *Was the flow seen to be as planned?*

Rated observation by the evaluator reporting on the sequencing design.

Q21. *Did the student understand the facilities offered?*

Rated observation by the evaluator reporting on the use of the systems facilities (Buttons: Analysis Report, Bibliography, Correct Answer, Diagram, Facility List, Help FAQ, Next Question, Restart Topic/Revision, Revision Answers - Hyperlinks: Answers Feedback, Change Feedback Response, Header Messages, Statistical Report.) - in some instances the student demonstrated good understanding without the use of the various facilities; thus no use or small use of the facilities did not result in a low rating - as with all ratings they are subjective to the evaluator's interpretation.

Q22. *Was the use of screen language correct for the student?*

Rated observation by the evaluator reporting on the Language Pattern used for the student.

How many times was each facility used in the Learning section?

This is the header question for the Control Topic Learning section. Each facility use was scored using the gate or tally system (𝍸) scoring fives. This section allowed use of the various facilities to be quantified and compared for each group and extrapolations to be made.

Q23. *Topic No. Hyperlink:* **Q24.** *Bibliography:* **Q25.** *Images:* **Q26.** *Next Question* and **Q27.** *Help FAQs.*

These questions Q23 to Q27 allowed the use of the various facilities to be quantified and compared for each group and extrapolations to be made. Each time a button or hyperlink was used the evaluator entered the fact with a stroke the space provided.

How many times was each facility used in the Topic Testing section?

This is the header question for the Control Topic Testing section. Each facility use was scored using the gate or tally system (卌) scoring fives. This section allowed use of the various facilities to be quantified and compared for each group and extrapolations to be made.

Q28. *Bibliography:* **Q29.** *Images:* **Q30.** *Submit Answer:* **Q31.** *Correct Answer:* **Q32.** *Restart Topic/Revision:* **Q33.** *Next Question:* **Q34.** *Analysis Report:* **Q35.** *Help FAQs:* and **Q36.** *Revision Question Answers.*

These questions allowed the use of the various facilities to be quantified and compared for each group and extrapolations to be made.

Questions 18 to 36 were designed to record the subjects' subjective feeling and actual use of the system. This enabled the results to be extrapolated and reported in the results.

8.4 Evaluation execution

Students in module for the final year HCI module CMSCD3001 'User Interface Design' module completed the evaluation over two distinct sessions.

- **In the first session** they completed a self-analysis evaluation. This entailed completing their own Communication Preference and Learning Styles psychometric tests and reporting on this task.

  The students were handed an evaluation form with questions that required an answer scaled between 0 and 10 (poor to excellent) on their own subjective feelings. It also asked questions designed to record their own thoughts by asking them to make comments in boxes.

The session averaged fifteen minutes per student.

- **In the second session** one student acted as the observing evaluator and the second acted as the subject. The task was to complete an observed evaluation of the Multi-choice Q&A topic learning and then topic testing.

The session averaged one hour per student.

8.5 Evaluation results

Of the 109 subjects 12 opted not to save their psychometric tests, no data has been saved or reported for these students in accordance with the Ethics Committee regulations. This report covers the other 97 subjects and is split into three sections Anecdotal, Subjective and Statistical:

- The *anecdotal evidence* reports on the subjective feelings reported by the respondents of their experience, feelings and thoughts of the evaluation and system results,
- The *subjective evidence* reports on the subjective analysis of the evaluation that used metrics to scale the respondents' replies,
- The *statistical section* analyses the hard data metrics.

The outcome of the evaluation gave the hypothesis[73] significant support

8.5.1 Anecdotal Evidence

The following are symptomatic of the comments made by subjects when completing the CP & LS questionnaires, and initial logon:

- Enjoyable to use, revealing, fun, excellent academic possibilities.
- The actual interface and results were amazingly accurate.
- Some of the questions were so close that it was difficult to know that I had selected the correct one - Selection from 2 questions is limiting, I would have preferred more choice
- I think that knowing your own communication preference and learning styles will prove very useful throughout the course of life.
- Use of colour was very good - Use of colour could have been better with more visuals - The interface was intuitive, user friendly and easy to use.

<u>Interactive Multi-choice Q&As - Comparative feedback</u>

Which did you find the most useful to you the control or the interactive?

Only 1 subject preferred the control, the balance felt that the interactive helped more - was easier to learn from and use - gave more practice - matched my personality and allowed me to control the interface - helped me to remember.

Which interface would you use the control or the interactive?

All subjects opted for the interactive: gives more information - makes it easier to remember and recall information from the memory - tells you which is the correct answer - gave me better results - the interactive has more learning advantages.

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[73] **Research hypothesises** - *"Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning"*.

What overall comments would you like to make of your experience?

- The interactive web browser interacted a lot more with me and got me excited - excellent development - found it good to learn from - it should link to the next question automatically rather than requiring you to click a button for it.

8.5.1.1 Conclusions from anecdotal evidence

Number of students using part 2. After logon, whilst the students were quite prepared to use the Topic Learning section, quite a few reported that they did not have time to spend completing the Topic Testing section. The former allows them to "*cherry-pick*" any topic and browse through the topic questions without testing their knowledge retention. The latter requires substantially more time to complete and runs as a sequential testing tool: the student must complete each topic testing in sequence before being allowed to progress to the next topic.

General feelings – were that and that bipolar questions were too limiting; however the CPLS reports were very accurate.

8.5.2 Subjective Evidence

Questions Answered

Each subject was asked to provide feedback with the questions about both the CP and the LS psychometric sections, these were scaled from 0 = poor to 10 = excellent (see Fig.140):

Q7 *Do you consider that this **Communication Preference** matches your own ideas?*

Mean Mark (MM) = 6.83

Q8 *Was this section easy to complete?* MM = 8.20

Q9 *Do you consider that these **Learning Styles** match your own ideas?*

MM = 7.21

Q10 *Was this section easy to complete?* MM = 8.09

Q11 *Did the report adequately reflect your input?* MM = 7.56

Q12 *Overall was the sequencing well presented?* MM = 8.03

Q13 *Overall did the Human Computer Interface act as expected?*

MM = 8.12

Q14 *Overall was the use of colour and presentation up to HCI standards?*

MM = 7.71

Q15 *How easy was it to complete **Registration**?* MM = 7.33

Q16 *How easy was it to* ***Logon****?* MM = 7.95

Q17 *How easy was it to enter your chosen* ***Module****?* MM = 8.79

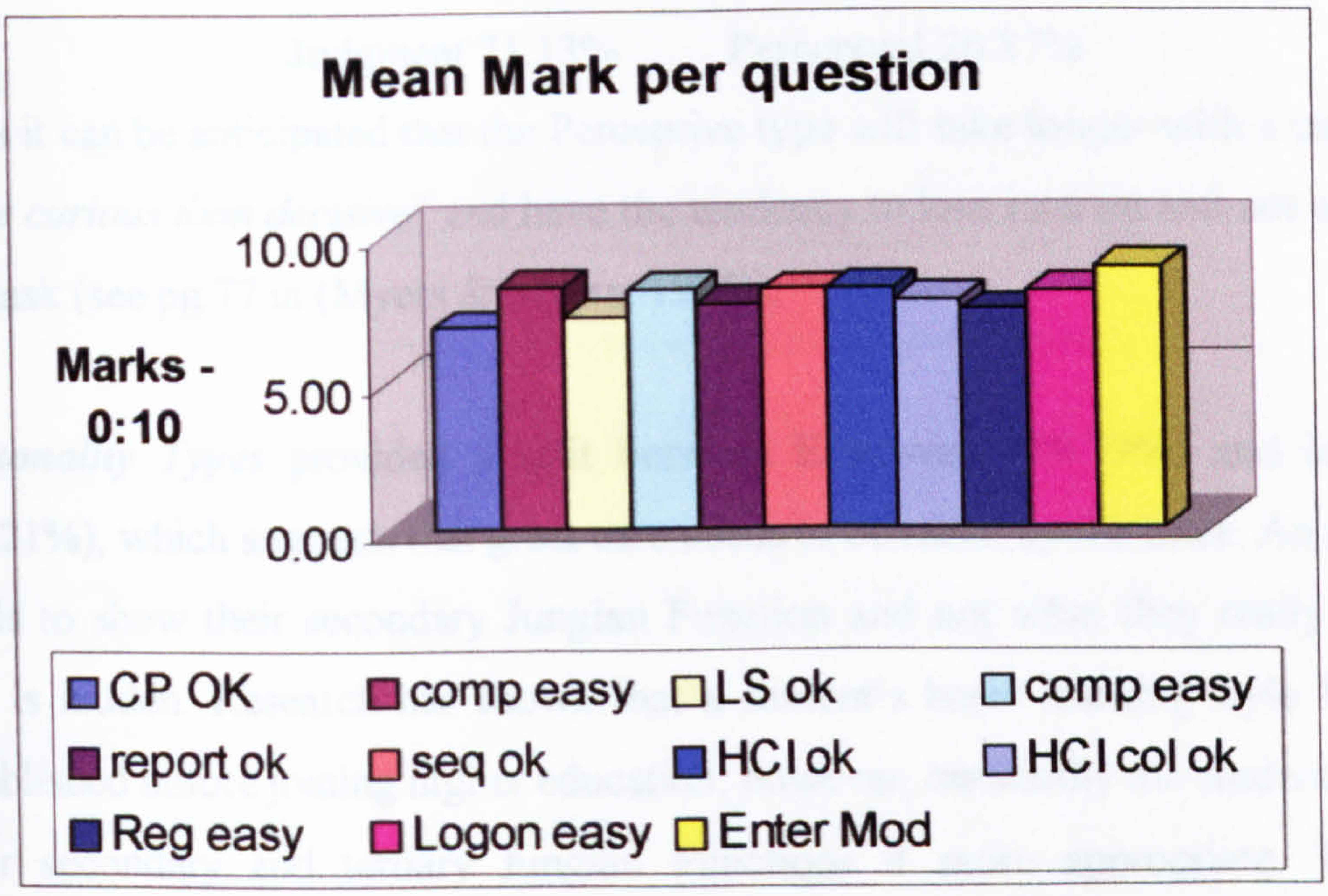

Figure 140 - Mean Mark per Question. This graph shows the average mark scored by each of the questions covering the Communication Preference and Learning Styles questionnaires: scaled from 0 (poor) to 10 (very good).

8.5.2.1 Conclusion from the subjective evidence

- ***VAK Communication Preference*** is reported generally as:

  V = 60% **A** = 30% **K** = 10%.

  The evaluation group's averages were:

  V = 67.01% **A** = 27.84% **K** = 5.15%.

  These compare quire well with previously reported research (Brown, 2001; Catania, 1992; Cotton, 1995; William A. Janvier & Ghaoui, 2003b); however, the group show a stronger tendency to visualization. This should reflect in memory retention data being stronger for this group than for the average due to the fact that the lecture content is based mainly on a visual presentation and auditory delivery styles. Hence comparative results in the future could well be skewed where the group balance was more kinaesthetic.

- ***Completion time of CPLS*** varied from 10 minutes to 30 minutes with the majority being very close to the group average of 15 minutes. The figures squared well with the fact that Decision Style affects the speed of completion of a task: Judgmental types tend to complete tasks faster than Perceptual. The totals of each type containing the J-type (ESFJ-ESTJ-ENSJ-ENTJ-ISFJ-ISTJ-INSJ-INTJ) as compared with the P-type (ESFP-ESTJ-ENSP-ENTJ-ISFP-ISTJ-INSP-INTP) was:

Judgment 71.13% Perceptual 28.87%

Thus it can be anticipated that the Perceptive type will take longer with a task being *more curious than decisive*" and have the tendency to lose interest and not complete the task (see pg.77 in (Myers & Myers, 1995)).

- *Personality Types* provided a split between Extroverts (59.79%) and Introverts (40.21%), which suggests that great care needs to be taken by the tutor. An introvert tends to show their secondary Jungian Function and not what they really require, this is hidden. Research has shown that a student's basic learning style has been established before joining higher education; however, outwardly the student will use their secondary and tertiary Jungian Functions if more appropriate. Thus the introvert often will use their secondary extrovert function to mask their introvert nature – from experience they have found that it is more appropriate (William A. Janvier & Ghaoui, 2003b; Wilson et al., 2002).

- *Questions Answered* - This graph shows the average mark scored by each of the questions covering the Communication Preference and Learning Styles questionnaires: scaled from 0 (poor) to 10 (very good). Actually completing the questions in the two questionnaires scored the lowest (6.83 and 7.21) whilst entering the module from the front page, with the psychometric tests having been completed earlier, was rated the easiest at 8.79. This reflects a feeling that, whilst completing the psychometric test was a required task, the actual use of the system was more interesting and gave more satisfaction. Indeed at 7.33 (Q15 Registration Easy), the third lowest, is also a task that is required once to enable access to the system.

8.5.3 Statistical Evidence

8.5.3.1 SECTION 1 - Evaluate LOGON and establish CPLS

This section had 97 responders (86 male, 11 female) as per Fig.4 that also includes non-replies. Their VAK communication preferences (see Fig.141) were:

Visual 67.01% **Auditory** 27.84% **Kinaesthetic** 5.15%

The average time to complete logon and the short questionnaire was 15 minutes.

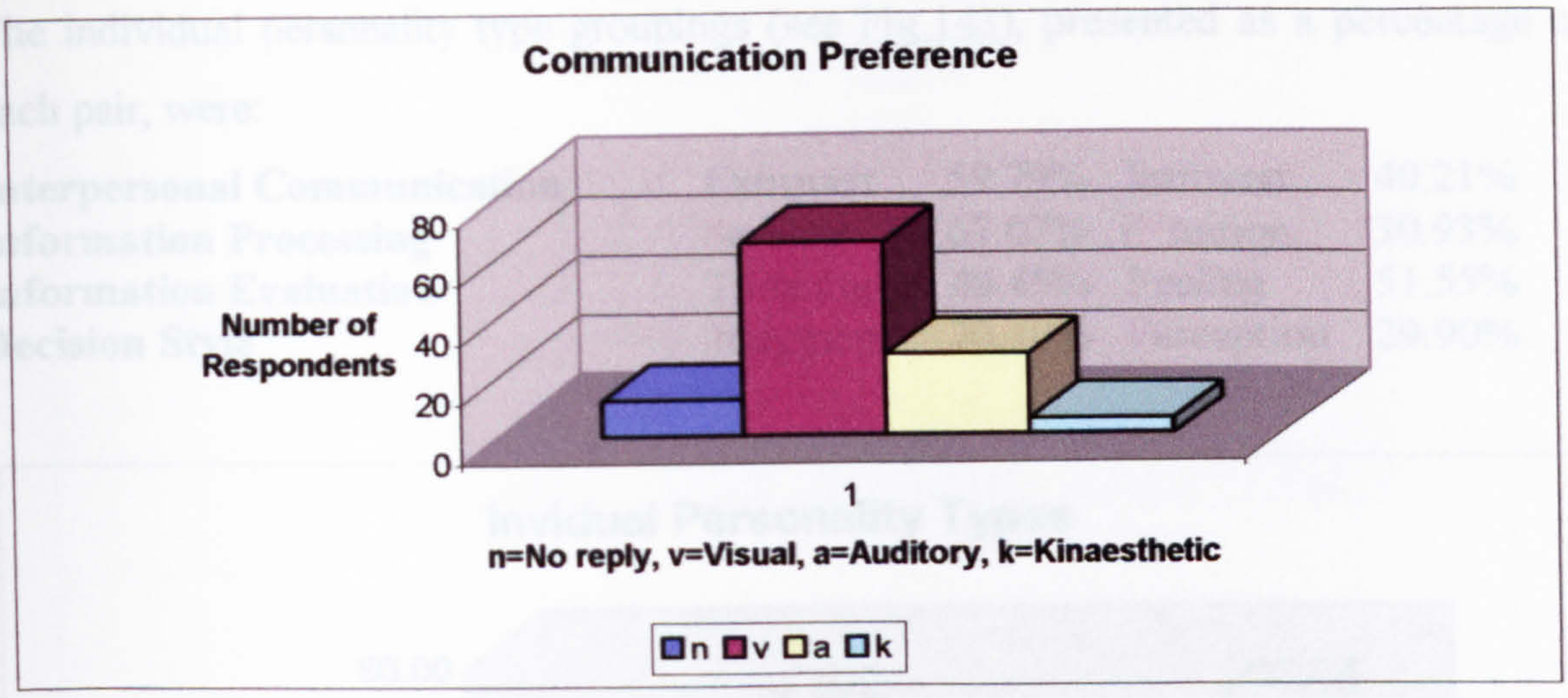

Figure 141 - Communication Preference – This diagram shows the Respondent Spread of preference between Visual, Auditory and Kinaesthetic. It also shows the number of respondents who preferred not to answer the communication preference psychometric test.

<u>Personality Types</u>

Each type was rated from 0 to 5 (see Fig.142). The average rating for the dominant type, from a possible rating of 3 to 5, presented as an average rating number, was:

Interpersonal Communication	Extrovert	3.55	Introvert	3.49
Information Processing	Sensing	3.97	iNtuition	3.23
Information Evaluation	Thinking	3.49	Feeling	3.62
Decision Style	Judgment	4.38	Perception	3.48

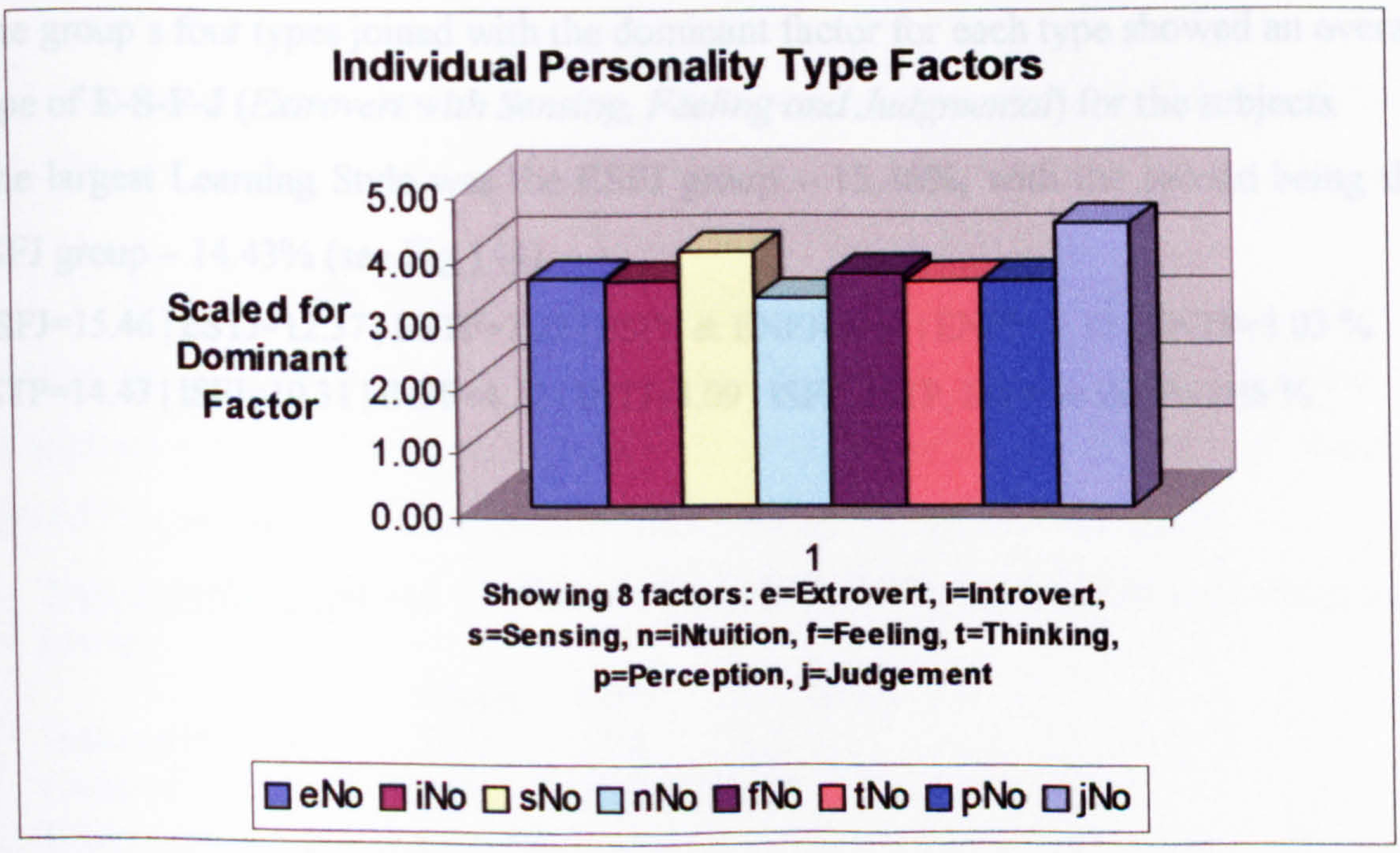

Figure 142 - Individual Personality Type factors. This diagram shows the average respondents' Dominant personality types rating (3 to 5) of each of the 8 types - Extrovert, Introvert, Sensing, iNtuitive, Feeling, Thinking, Perception and Judgment.

The individual personality type groupings (see Fig.143), presented as a percentage of each pair, were:

Interpersonal Communication	Extrovert	59.79%	Introvert	40.21%
Information Processing	Sensing	67.07%	iNtuition	30.93%
Information Evaluation	Thinking	48.45%	Feeling	51.55%
Decision Style	Judgment	70.10%	Perception	29.90%

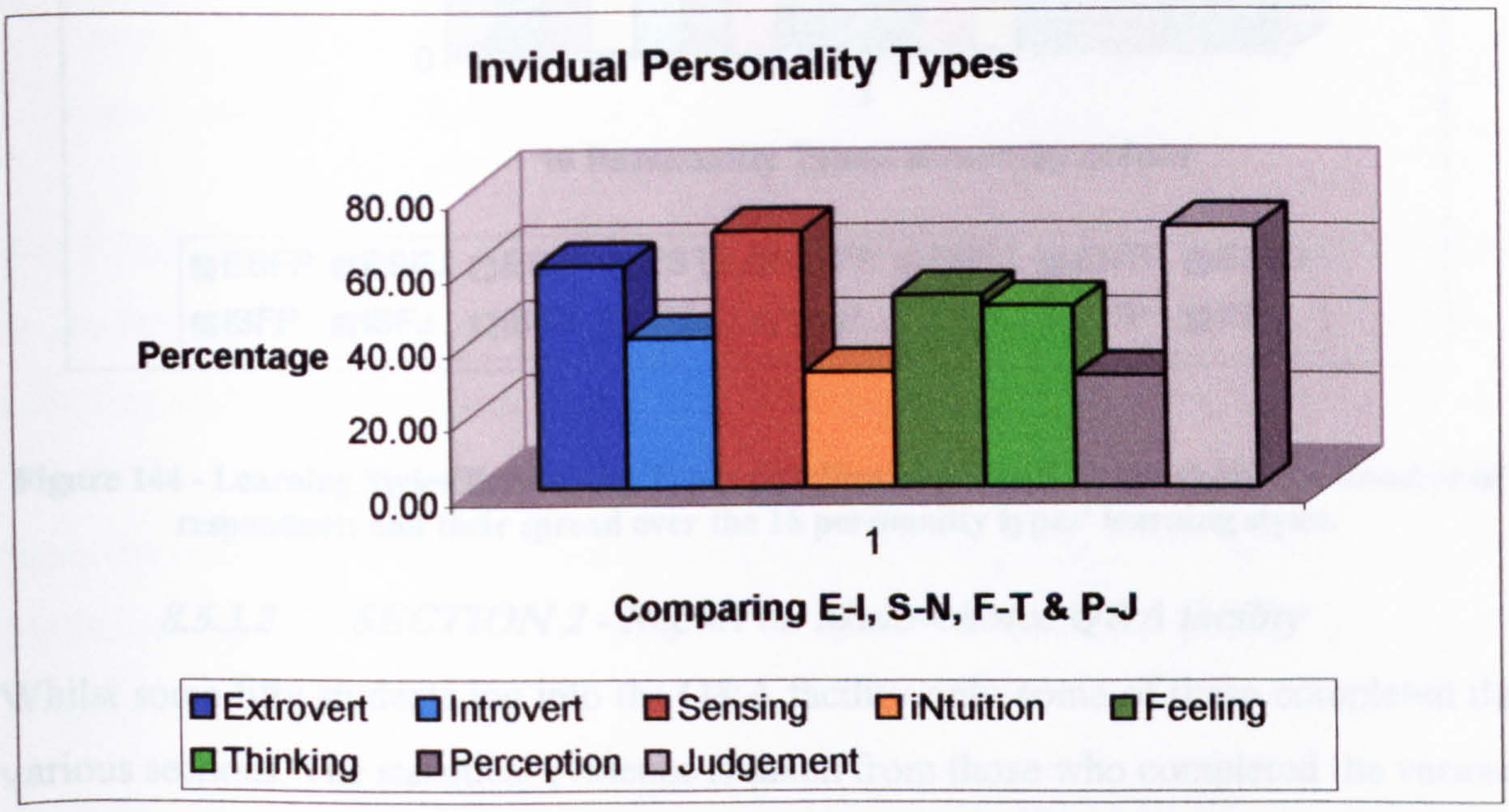

Figure 143 - Comparing Individual Personality Types. This diagram shows the percentage spread of the number of respondents per dominant personality types.

The group's four types joined with the dominant factor for each type showed an overall type of **E-S-F-J** (*Extrovert with Sensing, Feeling and Judgmental*) for the subjects. The largest Learning Style was the ESFJ group – 15.46%, with the second being the ISFJ group – 14.43% (see Fig.144).

ESFJ=15.46 | ESTJ=12.37 | ESTP=7.22 | ESFP & ENFJ=6.19 | ENFP=4.12 | ENTP=1.03 %

ISTP=14.43 | ISFJ=10.31 | INFP=4.12 | INTJ=3.09 | ISFP, ISTP, INFP & INTP=2.06 %

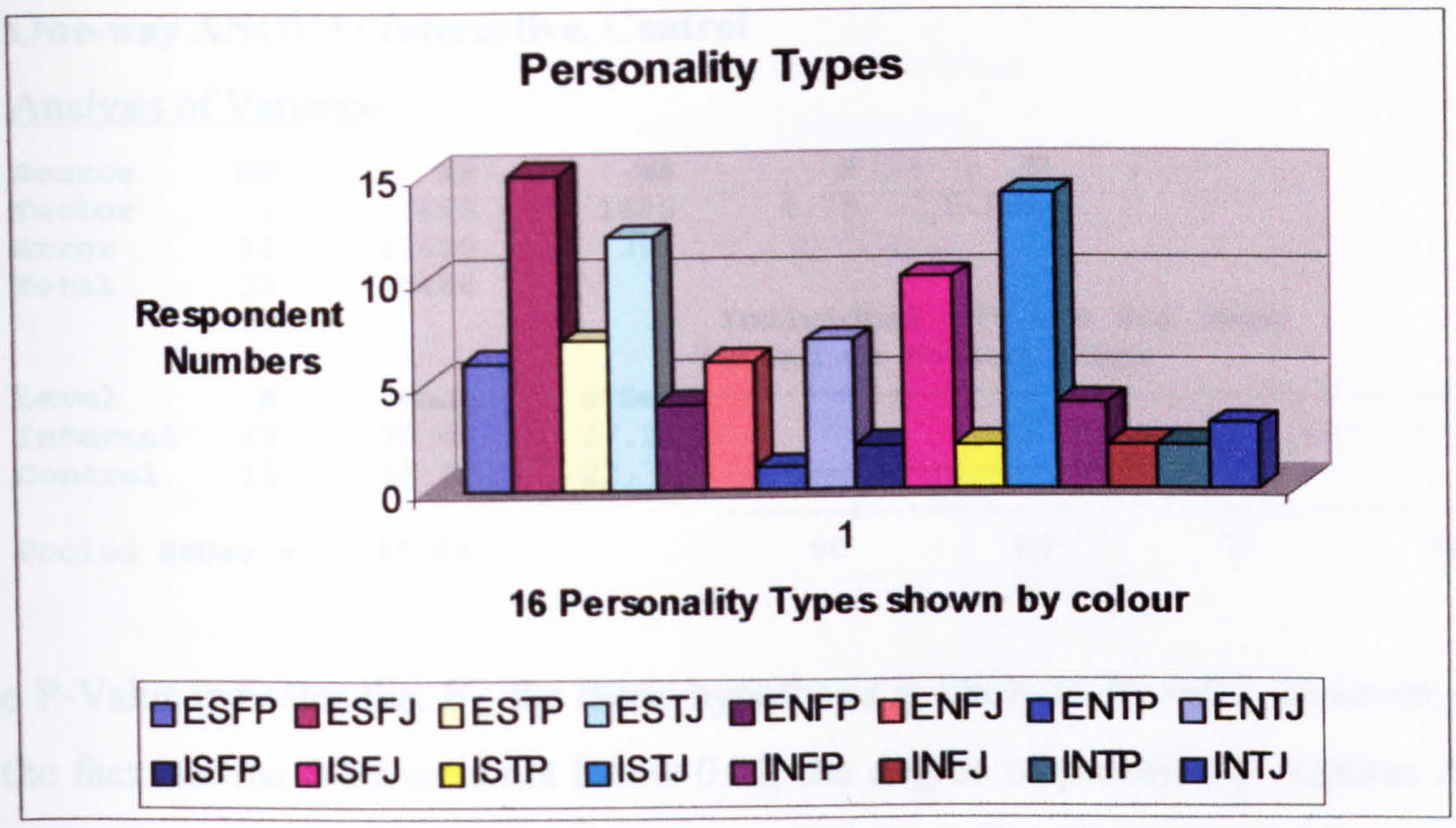

Figure 144 - Learning Styles/Personality Types distribution. This diagram shows the number of respondents and their spread over the 16 personality types' learning styles.

8.5.3.2 SECTION 2 - Report on Multi-choice Q&A facility

Whilst some fifty students log into the Q&A facility only some of these completed the various sections. The statistical evidence is taken from those who completed the various sections. Each statistical analysis shows the numbers involved in that particular analysis.

The average time taken by the students who completed the whole evaluation exercise (IG->CG or CG->IG) was 94 minutes: varying from 50min to 140min.

8.5.3.3 SECTION 2 - Two-Sample T-test and ANOVA

Comparing the marks for both sets of students (Interactive Group & Control Group)

34 students completed the tests of which 19 used the inITS and 15 used the standard non-inITS (see Fig.145 – Comparative Marks Analysis, Fig.146 – Boxplot).

<u>**Two-Sample T-test**</u> and Confidence Level (Cl) for Interactive and Control students Marks

	N	Mean	StDev	SE Mean
Interactive:	19	70.0	17.2	4.0
Control:	15	55.0	22.8	5.9

Difference = $\bar{x}\ x_1 - \bar{x}\ x_2 = 15$

95% **Cl** for difference: (1.04, 28.96)

Both use **Pooled StDev** = 19.8

T-Test of difference = 0 (vs. not =): **T-Value** = 2.19 **P-Value** = 0.036 **DF** = 32

One-way ANOVA: Interactive, Control

Analysis of Variance

```
Source      DF        SS        MS        F        P
Factor       1      1886      1886     4.79    0.036
Error       32     12600       394
Total       33     14486
                                   Individual 95% CIs For Mean
                                   Based on Pooled StDev
Level        N      Mean     StDev  ------+---------+---------+---------+
Interact    19     70.00     17.24                     (--------*--------)
Control     15     55.00     22.76   (---------*---------)
                                    ------+---------+---------+---------+
Pooled StDev =     19.84                  50        60        70        80
```

The P-Value indicates that H_a, the thesis hypothesis is likely to be valid; however, due to the fact that the P-Value is not below 0.01, the degree of probability requires more sampling to harden: more research results need to be gathered and assessed to enable this section of the results analysis to be viewed as supporting the hypothesis, at this time, the results, provided a strong indication that the hypothesis is true (see Fig.146 - Statistical Figures Boxplot[74] for both Two-Sample T-Test and ANOVA – results produced by Minitab).

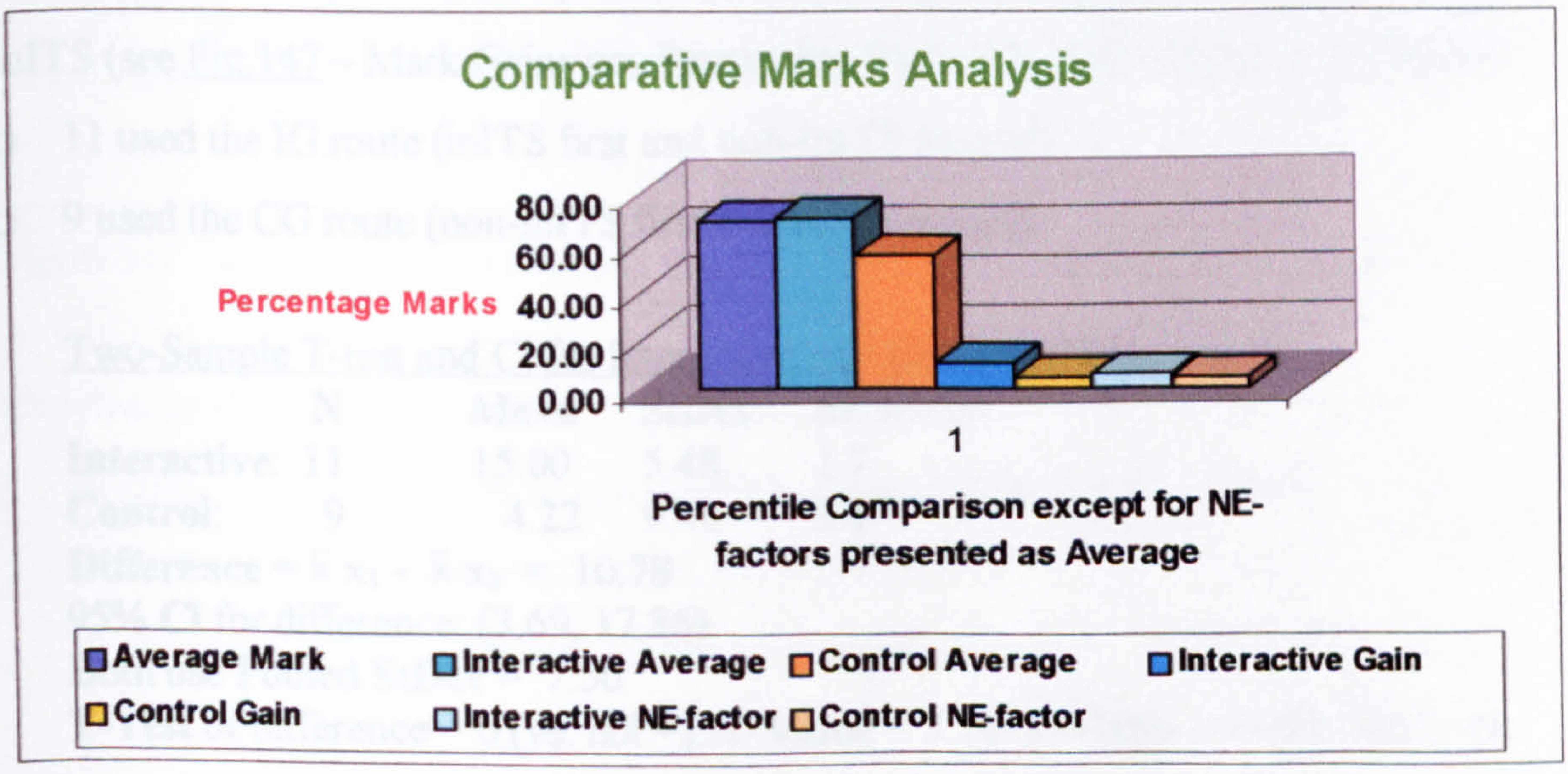

Figure 145 - Comparative Marks Analysis – percentage

[74] **Boxplot** - Gives a graphical summary of the values in a single column and helps to identify extreme values. The default boxplot display consists of a rectangular box, representing roughly the middle 50% (interquartile range or IQ Range) of the data, and lines (or "whiskers") extending to either side, indicating the general extent of the data. The median value is marked inside the box (see http://www.minitab.com/).

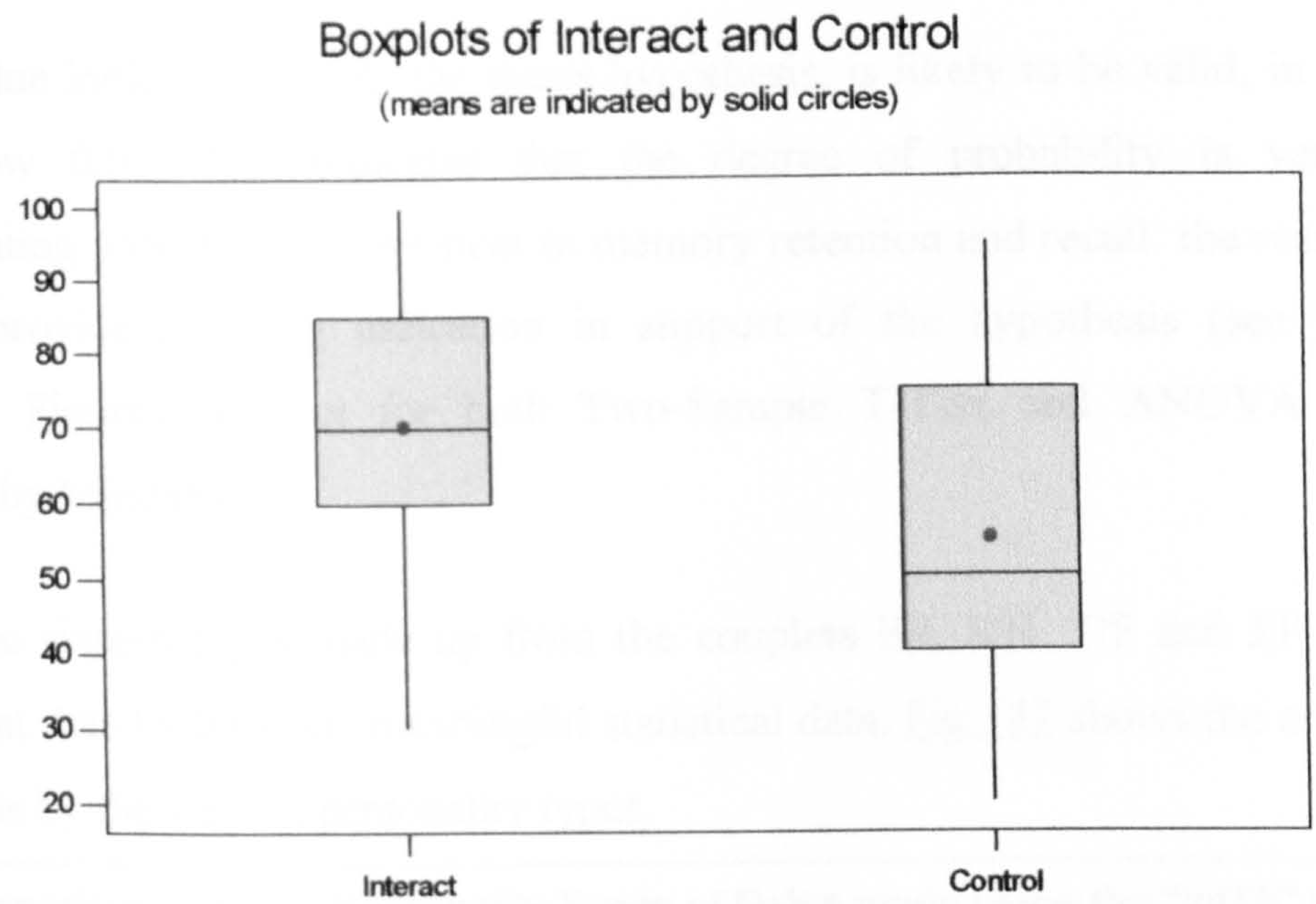

Figure 146 - Boxplot Graph - Comparison of Interactive and Control Marks

Comparing the gains made by students:

In this exercise 20 students completed the whole exercise using both the inITS and non-inITS (see Fig.147 – Mark Gains per Personality Type, Fig.148 – Boxplot of Gains):

- 11 used the IG route (inITS first and non-inITS second)
- 9 used the CG route (non-inITS first and inITS second)

Two-Sample T-test and Cl for Interactive and Control students Gain

	N	Mean	StDev	SE Mean
Interactive:	11	15.00	5.48	1.7
Control:	9	4.22	9.44	3.1

Difference = $\bar{x}\, x_1$ - $\bar{x}\, x_2$ = 10.78

95% **Cl** for difference: (3.69, 17.86)

Both use **Pooled StDev** = 7.50

T-Test of difference = 0 (vs. not =): **T-Value** = 3.20 **P-Value** = 0.005 **DF** = 18

One-way ANOVA: I-Gain, C-Gain

Analysis of Variance

```
Source    DF       SS       MS       F        P
Factor     1    575.0    575.0   10.21    0.005
Error     18   1013.6     56.3
Total     19   1588.6
                                Individual 95% CIs For Mean
                                Based on Pooled StDev
Level      N     Mean    StDev  --+---------+---------+---------+----
I-Gain    11   15.000    5.477                      (-------*-------)
C-Gain     9    4.222    9.444  (--------*--------)
                                --+---------+---------+---------+----
Pooled StDev =   7.504           0.0       6.0      12.0      18.0
```

The P-Value indicates that H_a, the thesis hypothesis, is likely to be valid, in particular well below 0.01. This indicates that the degree of probability is very strong demonstrating probable improvement in memory retention and recall: the results of the analysis provide a strong indication in support of the hypothesis (see Fig.148 - Statistical Figures Boxplot for both Two-Sample T-Test and ANOVA – results produced by Minitab).

Out of the sixteen types made up from the couplets E|I, S|N, T|F and J|P there was insufficient data to draw any meaningful statistical data. Fig.147 shows the comparative mark gains by the various personality types.

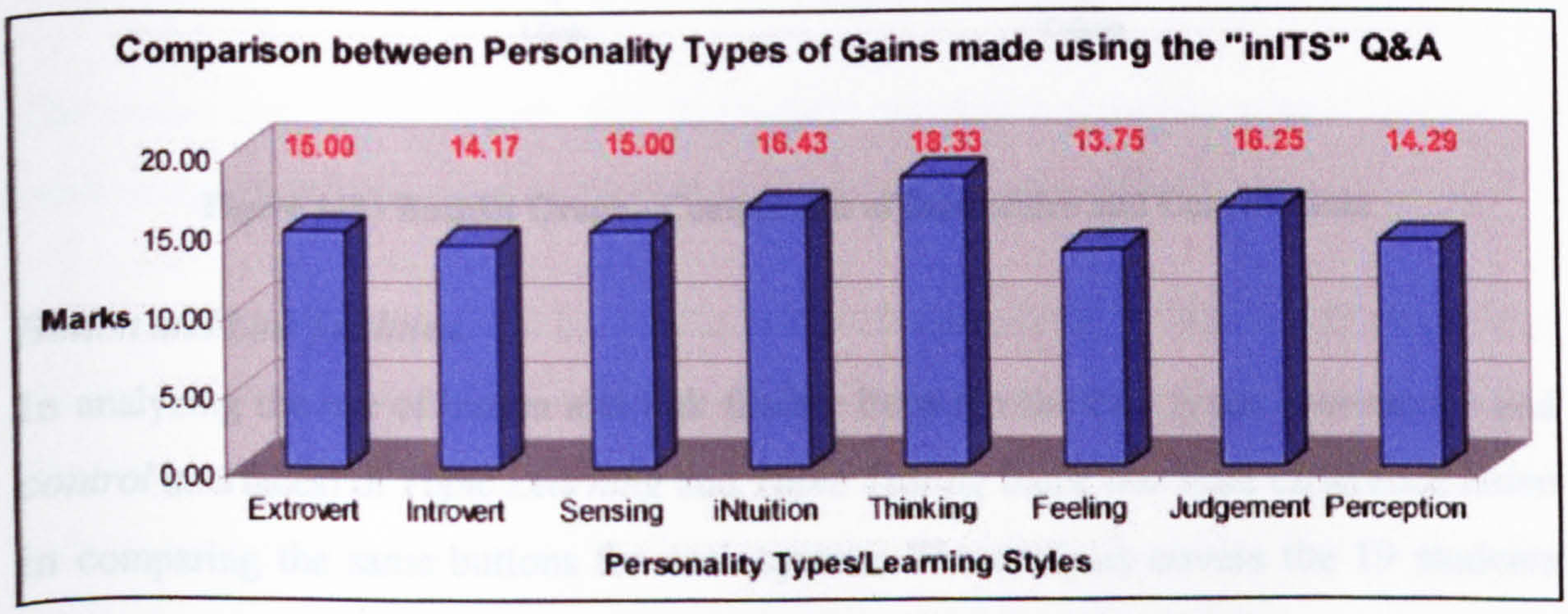

Figure 147 - Mark gains per Personality Types by students who used the 'inITS' system first and then the Control.

The four groups show the following mean results:

- *Interpersonal Communication* – Extroversion/Introversion 14.59
- *Information Processing* – Sensing/iNtuition 15.72
- *Information Evaluation* – Thinking/Feeling 15.64
- *Decision Style* – Judgment/Perception 15.26

(Borchert et al., 1999) reports that the Information Processing (sensing vs. intuition) category is seen by most researchers to be the most important of the four categories in terms of implications for education; and, whilst the results tend to support this, the comparative gain shown by all groups is very close: in particular the Thinking category suggests that this type makes the most when studying. The results suggest that all facets of personality type are important to remembering and that, where possible, need to be accommodated in the exchange and gain of knowledge.

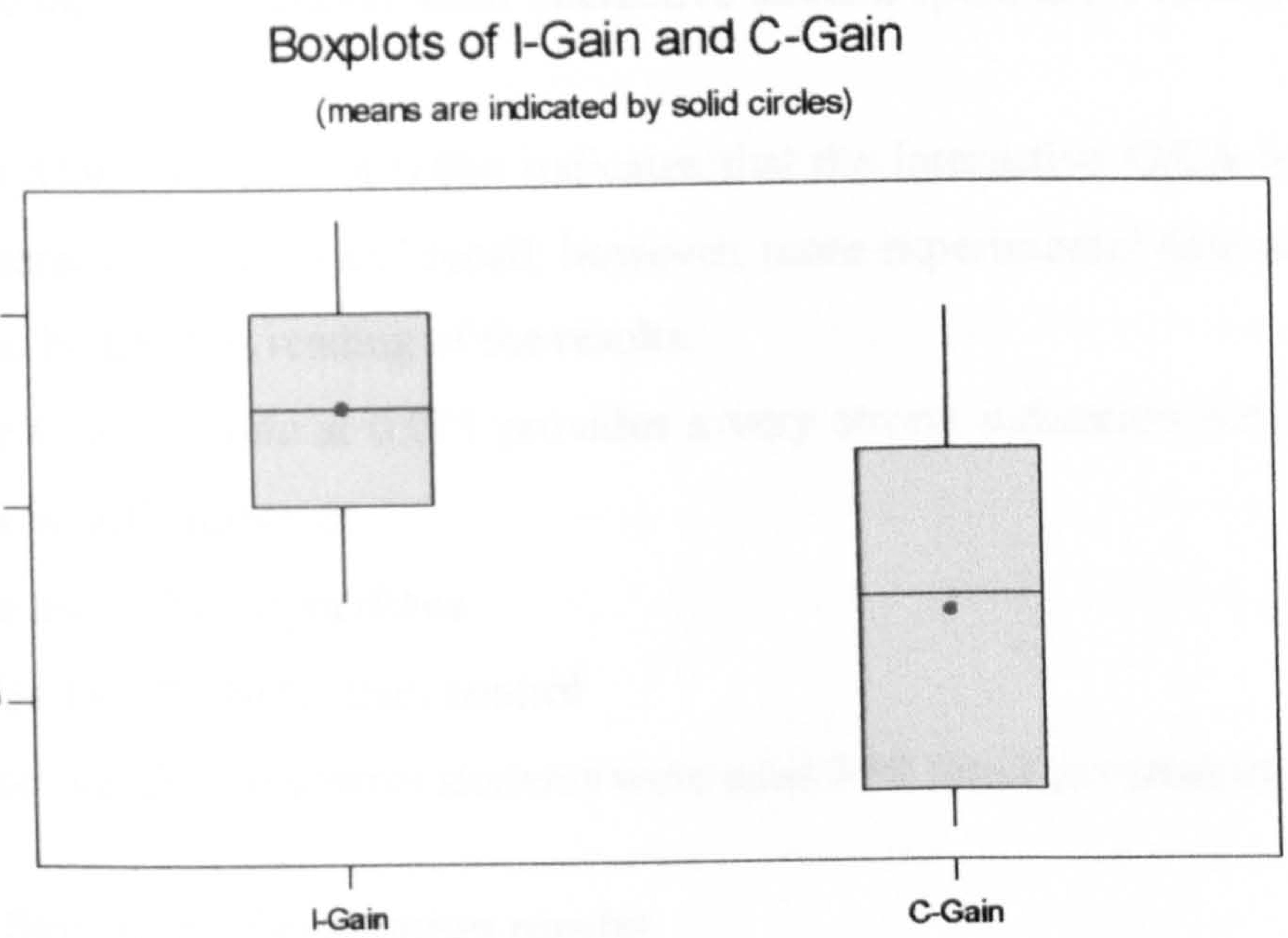

Figure 148 - Boxplot Graph - Comparison of Interactive and Control Gain

Button and Link facilities.

In analyzing the use of button and link facility between the two types (*interactive* and *control* interfaces) of *Topic Learning* and *Topic Testing* there was little difference noted in comparing the same buttons for each system. The analysis covers the 19 students who used the inITS first and the 15 who used the standard non-inITS first.

- *Control* students used the facility buttons 8.93 times each.
- *Interactive* students used the facility buttons 10.21 times each
- *Interactive* students had more link facilities that were not available to the control students. The average use of these interactive facilities per student were:
  - Header Messages link 0.50
  - Change Feedback Response 0.75
  - Header Message 0.75
  - Answer Feedback 1.00
  - Statistical Report 0.88.

8.5.3.4 Conclusion from statistical evidence

Improvement Analysis – In each section of the analysis (Interactive / Control Average, Interactive / Control Gain, Interactive, and use of facilities that both could use) the interactive returns were better than the control. In addition, due to the extra facilities available to the interactive section, each interactive student spent more time in memory rehearsal.

- *Interactive Marks P-value* at 0.036 indicates that the interactive Q&A is likely to improve memory retention and recall; however, more experimental data needs to be collected to harden this reading of the results.
- *Interactive Gain P-value* at 0.005 provides a very strong indication that the thesis hypothesis is well supported.
- *Interactive use of button facilities*
  - Was 14.33% better than control
  - Not available to control students were used 3.88 times per student.

8.5.4 Summary of evaluation results

The evaluation results indicate that WISDeM's intuitive interactive system is likely to make a significant improvement to student learning and remembering.

Taking into consideration that the results have to be tempered by the caveats previously discussed (see 3.3 – Pg.65 – Learning Styles – is their use justified?, 5.3.1.2 – Pg.101 – Communication Preference test – validity and 5.3.1.4 – Pg.103 – Learning Styles test – validity) concerning the validity of the instruments and the numbers involved in the evaluation exercise, measuring the evaluation results against the success criteria provided the following:

- *Did IG students demonstrate a larger gain in correct marks scored when answering the questions (in the Q&A facility) than the CG students?* **Yes,** P=0.005 (means of 15.00:4.22). This is a significant result, strongly supports the hypothesis that the inITS improves remembering and is strong enough to warrant further research.
- *Was memory retention improved more by the IG students than the CG students as evidenced by higher comparative marks?*

  Yes, P = 0.036 (means of 70.00:55.00). This is a significant result, quite strongly supports the hypothesis that the inITS improves memory retention.
- *Increase the correct marks scored for the IG route than the CG route – higher comparative marks for the IG students to CG students equates to success.*

  Yes, P = 0.036 (means of 70.00:55.00). This is a significant result, quite strongly supports the hypothesis that the inITS improves memory retention.

- *Increase memory rehearsal more by using the IG route – greater use of facilities (links and buttons) equates to success.*

  Yes. The interactive students used the facility buttons 10.21 times each plus they evidenced use of facilities not offered to the control students, whereas the control students used the facility buttons 8.93 times each. This indicates that the IG student appeared to be more involved and demonstrated greater interactivity.
- *Increase in enjoyment of and interest in using the system and therefore encouragement to learning – greater use of facilities (links and buttons) equates to success.*

  Yes. This was evidenced in the anecdotal evidence and also in the greater use of the facilities offered by the IG students. This indicates that the IG student appeared to be more involved and demonstrated greater interactivity.

In each instance the evaluation indicated support for the criteria and hypothesis pointing the way for further research.

Further conclusions can also be drawn from the evaluation:

- The trade-off between time to complete the questionnaires and providing more than a bipolar option was justified by the general consensus that the reports were accurate. Introducing more choice to the questions would require the user to spend substantially more time and yet not be likely to add significantly to the accuracy of the results.
- Most users reported that the CPLS report matched their own feeling very well and that the use of CPLS improved friendliness, usability and flexibility.
- The VAK comparative balances and the Learning Styles match closely to researched facilities and reports (William Alan Janvier & Ghaoui, 2002a; Sadowski & Stanney, 1999) - (Borchert et al., 1999; Fuller et al., 2000; William A. Janvier & Ghaoui, 2003b; Jensen et al., 2000; Lewis, 1998; Liu & Ginther, 2003; Murphy et al., 2002; Quenk & Kummerow, 2001; Rutz et al., 2000).
- The interactive system evidenced more rehearsal from students than the control system and evidenced improved marks: the students reported that it was easier and more interesting to use with greater facilities to research and rehearse knowledge.

- The students reported a general belief in the system, and considered that it did indeed assist knowledge retention: this in itself is an important factor for the students' psyche.
- As compared with the control system, the interactive system held interest longer and was more capable of interacting at the student's own level than the control system.

8.6 Chapter Summary

This chapter discusses Usability Evaluation, the various stages and evaluation methods. From this it covers the rationale and evaluation design selected for both parts of the evaluation, the Communication Preference and the Learning Styles. It highlights the fact that the former (CP) was comparatively easy to complete and thus was supported by many subjects, but that the latter (LS) took time, circa one hour for most and that, as a result the number of subjects was significantly reduced. It then goes on to discuss the actual evaluation exercise.

On analysis of the evaluation results[75], some significant statistics arose, in comparing the marks attained by the inITS students to the control students. In particular:

- The *inITS Marks P-value* at 0.036 indicates that the interactive Q&A is likely improve memory retention and recall; however, more experimental data needs to be collected to harden this reading of the results.
- In comparing the gains made by the IG students to the CG students the *inITS Gain P-value* at 0.005 provides a very strong indication that the thesis hypothesis is strongly supported,
- The *inITS student use of button facilities* was 14.33% better than control probably indicating more memory rehearsal

In brief, evaluation results of WISDeM's intuitive interactive multi-choice Q&A facility indicate that the system appears to aid memory retention and recall (remembering) and shows that the use of Neurolinguistic Programming Language Patterns used in an online learning DLT is likely affect the way students recall instances. It showed that Communication Preference and personality types Learning Styles used in Human-

[75] **Considering the caveats** covered in 3.3.2 – Pg.85 – Learning Styles – is their use justified?, 5.3.1.2 – Pg.120 – Communication Preference test – validity and 5.3.1.4 – Pg.122 – Learning Styles test – validity, concerning the validity of the instruments and the numbers involved in the evaluation exercise.

Human Interaction and established BEFORE the student starts using the system is an important message to take forward.

As stated above the results have to be tempered with the caveats in footnote 80 and that the sampling was low in numbers, that the respondents were from the same year and discipline and lacked depth of female respondents, that not sufficient experimental work has been executed to isolate any one part of the experiment (the Communication Preference, the personality style Learning Types, the different ingredients in the intuitive interactive interface and the affect that they had on the respondents); however, the conclusion, that this research points the way for more in-depth work, is valid.

CHAPTER 9

CONCLUSION

AND SOME SUGGEST

FUTURE WORK

9 Conclusion and some suggested Future Work

This chapter covers:

- The introduction to the thesis
- The main contribution made by this project
- The originality
- The contribution
- The difference to other online DLTs
- A summary of each chapter
- Conclusions
- Future work

9.1 Introduction

Current HCI online DLTs do not replicate normal HHI and thus a student's learning experience using these tools lacks the face-to-face interactions and learning/tutoring that such an experience provides. From this, the concept of creating an inTS that matched HHI was formed: it was realized that solving the totality was too daunting for one project and that a start was needed 'somewhere'.

This led to the inception of the project thesis: "*Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning*".

To match a student Communication Preference and Learning Styles before he/she starts using the system requires him/her to take two psychometric tests and the creation of a Student Profile. To be effective, not only does the system need to record these, but it also needs to take cognizance of Motivational Factors, a Novice/Expert Factor to enable the system to work seamlessly with the student as he/she develops.

WISDeM has been successfully developed to offer a Human-Centered Generic inTS for higher education in line with the requirement for one-to-one interaction between student and tutor: the tutor being replaced by the system that replicates in part this interaction. It offers the necessary Intuitive Interaction whilst maintaining at all times the KISS principal.

9.2 This Project's Main Contribution

In this section the project's originality is briefly discussed and the contribution to the world of academia and the difference between WISDeM and other online DLT highlighted.

9.2.1 Originality

Of all the systems reviewed, which offer online DLT, only REDEEM came close to offering an inTS. REDEEM addresses macro and micro level of instruction with the latter including i) When and How to give explanations, summaries, examples and analogies, ii) What type of hinting and feedback to give, and iii) What type of questions and exercises to offer the student. It relies on the tutor to program the teaching strategy and research has shown that different teachers use different teaching strategies for the same student. This relates well to the fact that introvert students are not likely to show their primary Jungian function but rather their secondary or tertiary, according to their conceptual ideas of the best way to face the world, and thus be categorized by their tutor/s incorrectly.

WISDeM's originality lays with the fact that the student's communication preference and learning styles are discovered first and applied by the system's algorithms to change output to match this profile as soon as the student starts using the inTS. It has been shown that this has a positive affect on student remembering (storing and recalling data from memory).

9.2.2 Contribution

The project's main contribution is the partial replication of HHI to HCI is that the WISDeM system successfully introduces an HCI that matches each student's psychological requirements with reference to matching their communication preference and learning styles. WISDeM also introduces a measure of motivational reward and statistical reporting that matches each users psyche.

In short the project's main contribution is that the student has a system that matches his/her own personality and thus enhances his/her ability to learn – enjoy the experience, remember and recall knowledge significantly more than without a match.

To summaries, the main contribution of this PhD project, in this area of research and development, has: i) brought HCI and related disciplines (computing, psychology and education) into e-learning, ii) modelled the student and enhanced the inTS design for the student's benefit, iii) started to bridge the identified gap, and iv) is guided by a flexible and Human-User Centred approach.

9.2.3 Difference to other online DLTs

Typically online DLTs offer a content module that provides the student with details of the syllabus, the facility to search the site, read tutorial notes, additional pertinent information, and see slides or movie/audio clips of the lecture. The content module also has links to a library or libraries and other sources of relevant reference. The online DLTs typically also offer other communication tools such as e-forums, e-mail, chat, a calendar, and assessment tools such as quizzes, surveys, self-testing, and assignments.

In addition to these the WISDeM system offers an intuitive interactive multi-choice Q&A facility whose interaction is designed to interface with the student's Communication Preference (CP) and Learning Styles (LS) by using neurolinguistic programming language patterns, motivational feedback and novice|expert factor (NE) dynamically change by the changing student profile (SP). The SP is made up of a combination of CP and LS plus a NE factor that reflects the student's knowledge state as he/she moves through both the topic and module. The system also offers a wide range of facilities, such as feedback, statistical reporting, and control over the interface output.

In brief the system offers, to the student, an intuitive interactive interface that is designed to react with his/her personality requirements.

9.3 Contribution from each Chapter

The following is a summary of the contribution each chapter made to this report.

9.3.1 Chapter 1 – Introduction

This chapter briefly summarized the project's motivation and main contribution, research rationale and hypotheses on which the thesis is based: the student has a system that matches his/her own personality and thus enhances his/her ability to learn – enjoy the experience, remember and recall knowledge significantly more than without a match. It also provided a list and details of published papers.

9.3.2 Chapter 2 - Literary Review – Distance Learning (and E-learning) & Intelligent Tutoring Systems

This chapter confirmed that the projects research into both DLTs and ITSs indicated that a using a student's Communication Preference and Learning Styles from inception, and providing timely motivational input, following testing the quality of his/her learning, have not yet been offered. The research also provided confirmation of the necessary components in an inTS.

9.3.3 Chapter 3 - Communication Preference & Learning Styles

This chapter enabled the system to take cognizance of the fact that subjects prefer to use different communication preferences and learning styles. It showed that iconic memory has a latency, which it uses in subliminal text messaging; and, that learning is enhanced if a system encourages memory rehearsal. The psychometric tests were built using the concepts developed by VAK, MBTI and Maslow. In particular the validity, reliability and limitations of MBTI were discussed.

9.3.4 Chapter 4 - WISDeM - Framework

This chapter outlined the system's design and development. It provided a detailed framework for the development and confirmed that the inTS uses Communication Preference, Learning Styles, Novice|Expert factors and Motivational factors to output data from the system that reflects the current Student Profile state and provides the relevant motivational feedback and information (both autonomous or selected) and further provides the student with the facility to control the nature of the output (restrict it or expand it). It enhances learning.

9.3.5 Chapter 5 - WISDeM – Intuitive Interaction

This chapter discussed the importance of using communication preference, learning styles and motivational factors and showed how these have been successfully built into the system. It also provided a discussion on the validity, reliability and limitations of the two instruments developed (CP and LS psychometric test) and provided concepts for future development in this area. In particular, the chapter outlined the pedagogical standards required for the system to work.

9.3.6 Chapter 6 - Design & Development

This chapter provided a detailed account of the way WISDeM has been designed and developed and basic design concepts incorporated. It also gave an overview of the algorithms used in the inTS section and touched on the authoring system.

9.3.7 Chapter 7 - Scenario

This chapter provides a scenario of a composite student drawn from the evaluation of the system and the feedback provided concerning the students' use of the system. It confirmed that most of the students preferred the interactive rather than the control multi-choice Q&A, and that the results confirmed that memory rehearsal is encouraged by the system; indeed most students noted that they were more interested and enjoyed the inTS better than the control system.

9.3.8 Chapter 8 - Evaluation

This chapter reported on Usability Evaluation, how the evaluation was planned and executed and then looked at the anecdotal, subjective and statistical evidence produced by the evaluation. It demonstrated that, on the evidence produced, the system does in fact aid memory retention and recall, that the use of Neurolinguistic Programming Language Patterns used in an online learning DLT can affect the way students recall instances and, finally that Communication Preference and Personality Types used in Human-Human Interaction and established BEFORE the student starts using the system is an important message to take forward.

9.4 Conclusions

Subject to the caveats discussed concerning the number of respondents in the evaluation, the requirement for more strenuous research into the validity and reliability of the two psychometric test developed, but also bearing in mind the significant statistical support provided by the evaluation results:

- The system supports the online learning DLT project research results by offering a wide range of HCI facilities including intuitive interaction that takes into consideration the student's profile: this includes his/her own psyche, communication preference and learning styles (personality types).
- The HCI interaction with the system is seamless and watches how the student proceeds and, from the recorded data and observations, ascertain the student's knowledge state
- The system encourages the student's memory rehearsal and thus encourages learning.
- The system also acts autonomously, or by the student's request, and is guided and informed by the student model. It provides additional pedagogical materials to enable greater depth of memory rehearsal.
- The project's research and results indicate that automatically mapping the system to the student's profile (his/her *Communication Preference* and *Learning Styles*), coupled with dynamically changing the *Novice/Expert leve factorl* and including relevant *Motivational Factors*, enhance his/her level of knowledge retention and recall.
- The projects research confirms that psychometric tests, similar to VARK and MBTI, play an important part in assisting memory rehearsal and need to be employed and encapsulated in the system's interactivity **BEFORE** the student starts to use the system.
- The evaluation study of WISDeM's system showed that:
  - The intuitive interactive system, in the way it interacts with learners, makes a significant improvement to student's learning and remembering.
  - The majority of students reported that the psychometric tests:
    - Matched their own feelings and understanding
    - Provided results that closely matched other researched facilities and reports
  - The system:
    - Invoked more rehearsal from students as indicated by improved marks and greater use of facilities
    - Was reported as being easier and more interesting to use with greater facilities to research and rehearse knowledge generating a 'belief-in-the-system' and that it would assist knowledge retention

- Held interest longer and interacted at the student's psyche level
- Does aid memory retention and recall, which in turn contributes significantly to better learning.

9.5 Some suggested Future Work

The following is a list of some interesting further work that could be implemented.

9.5.1 Enable full SQL database connectivity

At this time WISDeM still requires further development to enable full scalability. The current link using an Access database has worked well for the development and the evaluations completed provided evidence that supported the research hypothesis. Access provides support where only a few simultaneous hits are made on the database; however, for scalability, the database support needs an SQL database that supports simultaneous hits. The initial entry into the system uses the SQL database; however, whilst the whole system has been converted on a trial basis with apparent success, the system needs to be extensively tested to ensure that the transfer to SQL does not adversely affect any part of the intuitive interaction, or, indeed any other part.

9.5.2 Complete the Administration system coding

Certain sections of WISDeM require some development work and coding such as the adding, deleting and amendment of questions linking to answers, feedback and images. These are currently administered by database changes rather than administration front-end changes.

The coding in Revision Topic Learning allows the student to select any week/topic on which to revise; however, as implemented at this time he/she does not have the facility to choose a specific start point within a topic; whilst this has been coded and is working, it has not been released until a slight bug has been removed: this needs to be implemented.

Further research will be needed to establish if Long Term Memory has been in fact improved. The current evaluation made an assumption that "*using both groups over a short period of time to test short-term memory retention would provide results that* *emulated the long-term memory retention figures except in the totality of retention*". This assumption needs to be validated.

Looking at the results over a semester and comparing both the control and interactive groups could enhance the proof of long-term memory retention.

9.5.3 Other Potential Developments

Due to the fact that most students are visualizers the system has been built with a visual bias. Thus further development could include:

- Auditory components - here the introduction of sound would assist the echoic CP type; however, it is not envisaged that tutors would be asked to translate all the inTS section to sound, but that, rather like Adele (Shaw et al., 2000) the system would execute this action. One criterion that is essential is that the sound must be produced by a voice that the student likes; thus, the requirement for the student to be able to select a voice that is acceptable[76]: a matching of the interactive games world with the inTS world.

  The introduction of an acceptable auditory system to WISDeM would mean that the echoic student would have an automatic sound element to add to the current iconic inTS. Once again this would need to be under all students' control so that anyone (iconic, echoic or kinaesthetic) could switch the sound on or off.
- Kinaesthetic components – haptic/emotional are somewhat harder to emulate. Once again current research is developing this for the blind (see (Sjöström, 1999)) and in immersive virtual reality the user becomes fully immersed in an artificial, three-dimensional world that is completely generated by a computer with the three main senses covered (see Virtual Reality: A Short Introduction - http://www-vrl.umich.edu/intro/).
- An avatar with automated eye movement matching the student's Communication Preference, pupil size and facial changes to indicate the acceptability of an answer or passage of time, linking speech to text, and the facility for the student to choose both face and voice are interesting future goals to work towards (Colburn et al., 2000; Deray, 2002).

[76] Current PC games, such as Morrowind by Bethesda Software LLC, provide players with this facility.

Currently Adele is a good example of this type of development - see (Shaw et al., 2000); however, unlike Adele, which shows a full figure avatar, the above suggests the avatar being a full face with full facial interaction.

The advantage of this is that the student would receive both iconic and echoic input that reflected both his/her own current knowledge state and communication preference with the avatar transmitting relevant body language.

- Study of the science of Cognitive Psychology as linked to educational development and Educational Psychology and inclusion of these into WISDeM (Liu & Ginther, 2003; Polson, 1988). This would further enhance the system's ability to interact with the student; however, here it would be necessary, to develop different scenarios to cover the same learning material. Whilst a dedicated tutor can achieve this, being able to replicate this automatically is likely to take much research.

9.6 Chapter Summary

This chapter outlined the future work that could increase WISDeM's functionality. It highlighted the development required to increase scalability to enable the system to be used as a general system, and the requirement for further evaluation to confirm the effect on Long Term Memory retention. It then went on to introduce the concept of the avatar interaction and research required into cognitive psychology and linked educational psychology.

This thesis developed the research hypothesis that "*Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning*" and showed that the evaluation indicated that the evaluation of the WISDeM system indicates that the system does in fact aid memory retention and recall, that the use of Neurolinguistic Programming Language Patterns in an inTS can affect the way students recall instances, and finally that Communication Preference and Personality Types used in Human-Human Interaction and established BEFORE the student starts using the system is an important message to take forward.

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This alaphabetically lists Web references for Reviewed Intelligent Tutoring Systems.

AHAM
http://wwwis.win.tue.nl/~hongjing/pub/edmedia99.html
ANDES
http://www.press.umich.edu/jep/06-01/schulze.html
http://www.pitt.edu/~vanlehn/andes.html
CiRCSUM
http://www.cs.iit.edu/~circsim/
CREAM
http://helios.hampshire.edu/~tjmCCS/papers/ATSummary/AuthTools.html
http://citeseer.nj.nec.com/25658.html
DIAG
http://computing.unn.ac.uk/staff/cgpb4/ijaied/abstracts/Vol_8/murray.html
ELM-ART
http://www.psychologie.uni-trier.de:8000/projects/ELM/elmart.html
http://citeseer.nj.nec.com/weber97user.html
ELIZA
http://www.manifestation.com/neurotoys/eliza.php3
EON
http://www.wpi.edu/Pubs/ETD/Available/etd-1222103-161814/unrestricted/vcsizmadia.pdf
FGA/FROG/LINGER
http://www.intellectbooks.com/authors/lawler/its.htm
GTE
http://reo.nii.ac.jp/journal/HtmlIndicate/Contents/SUP0000001000/JOU0001000224/ISS0000006579/ART0000071625/ART0000071625_abstract_en.html
gwTTS
http://www.cs.virginia.edu/~gwtts/
IKITS
http://svenska.gu.se/~svesj/IKITS/IKITSeng.html
IMITS
http://fie.engrng.pitt.edu/fie2000/papers/1063.pdf
IntelliMedia Initiative
http://computing.unn.ac.uk/staff/cgpb4/ijaied/members99/archive/vol_10/lester/full.html
Interbook
http://www.contrib.andrew.cmu.edu/~plb/InterBook.html
IRIS/IRIS-Tutor
http://computing.unn.ac.uk/staff/cgpb4/ijaied/abstracts/Vol_8/murray.html
ISIS
http://www2.sis.pitt.edu/~peterb/papers/EWED.html
LEAP
http://leap.sourceforge.net/
Ms. Lindquist : The Tutor
http://www.cs.cmu.edu/~neil/
http://gs260.sp.cs.cmu.edu/diss/TableOfContents.html
LISP Tutor
http://www.cs.mdx.ac.uk/staffpages/serengul/LISP.TUTOR.htm
MANIC

http://citeseer.nj.nec.com/stern97intelligence.html
http://www-aml.cs.umass.edu/~stern/manic.html
MYCIN
http://www.cee.hw.ac.uk/~alison/ai3notes/section2_5_5.html
REDEEM
http://www.psychology.nottingham.ac.uk/research/credit/projects/redeem/main.html#ongoingresearch
RIDES
http://btl.usc.edu/rides/index.html
SCHOLAR
http://www.lis.uiuc.edu/~chip/projects/timeline/1969an.html
SQL-Tutor
http://www.cosc.canterbury.ac.nz/~tanja/sql-tut.html#overview
XAIDA
http://computing.unn.ac.uk/staff/cgpb4/ijaied/abstracts/Vol_10/hsieh.html

Other references

Andes : http://www.pitt.edu/~vanlehn/distrib/Papers/gertner.pdf
I-Help: http://www.cs.usask.ca/i-help/private_tour/private_tour.html
Virtual Reality: A Short Introduction: http://www-vrl.umich.edu/intro/
WISDeM: http://cmswjanv/janvier/wisdem (intranet)

APPENDIX

Appendix

This appendix covers:

The Ethics Committee submission

The project Details document

Two sets of evaluation forms: the first split into two parts to enable the evaluation to be spread over a period of time; this was the one used by the students CMPCD3009, and the second designed to be used in one long session.

Ethics Committee Application

APPLICATION FOR APPROVAL OF AN INVESTIGATION FOR TEACHING, TESTING OR RESEARCH INVOLVING HUMAN SUBJECTS

THIS APPLICATION MUST BE TYPED.

In designing a research, teaching or testing project involving human subjects, investigators must be able to demonstrate a clear intention to benefit society and the project must be based on sound scientific principles. The Ethics Committee will consider these criteria before approving a project or practical demonstration.

Applicants are strongly advised to read copy of notes for guidance & discuss their project with their supervisor before completing/submitting an application to Ethics Committee.

SECTION A: THE APPLICANT

A1.Full Name & Status (e.g. staff/student)	William Alan Janvier - student
A2.Relevant Qualifications	B.Sc.(Hons)

A3.Address for correspondence from the Ethics Committee (it is important that you notify the Ethics Secretary of any changes to this information).

Room 625 - James Parsons Building,
Liverpool John Moores University
Byrom Street - Liverpool - L3 3AF

SECTION B: THE PROJECT

B1.What is the title of this investigation

WISDeM - a Human Computer Interactive Model for e-Learning

B2.Is this investigation (*please tick*):

a research project?	√	a teaching exercise?	
an undergraduate project?		testing on members of the public?	

B3.Have the full details of the procedure been appended? (please tick) yes √ no

B4.Likely duration of project and location of study:

start date: May 2003 or sooner as agreed

end date: June 2003

location: James Parsons Building - Byrom Street - Liverpool - L3 3AF

B5.Brief description of the ethical nature and purpose of investigation

The research vision is that "A virtual university should be, to the learner, a distance or online learning environment that can be transmitted via the world wide web by an intelligent tool that is intuitive to use, a simulation of the real-world learning experience and, at all stages, interacts with the learner's changing profile". WISDeM is being developed to offer a Generic Intuitive Interactive Distance Learning Tool for higher education. The whole emphasis of the research is that the system should first establish a Student's Profile (his/her Communication Preference and Learning Styles) and automatically map this to Teaching Styles.

B6.Briefly, what benefit to society will accrue from this project?

Students should find that acquiring, remembering and recalling knowledge is easier, more rewarding and interesting.

B7.Specify the particular procedure which involves the subjects participation

1 Using WISDeM

The student is asked to complete a Communication Preference (CP) questionnaire (based and developed on Flemings VAK psychometric test) by selecting only those statements with which he/she agrees. This establishes the student's CP. Using the relevant Neurolinguistic Programming Language Patterns for iconic (V), echoic (A) and kinaesthetic (K) types the bi-polar Learning Style (LS) questionnaire establishes the student's rated personality type (based and developed from Myers-Briggs MBTI) from one of sixteen types (Extravert or Introvert, Sensing or iNtuition, Thinking or Feeling, and Perception or Judgement). The resultant CPLS is used to change the way the Human Computer Interface interacts with the user in real-time.

The student selects either complete the CPLS or enter the module at once: the former completes the psychometric tests, receive a report, their CPLS is recorded and they open their module front page, the latter see their module front page and the system records an 'n' for their CPLS.

2 Unsupervised evaluation (quantitative analysis) - scheduled soonest

Up to 150 students are to be asked to use WISDeM as a normal revision tool: they are not being actively observed at an evaluation session. These students will enter the revision session and use this for revision: 50% (those with a CPLS) will see a fully interactive Questions and Answer (Q&A), and 50% (including the 'n's) will see a normal Q&A. Both types are asked to give electronic feed back if they wish. The results for both will be logged in the database to enable quantitative analysis.

3 Observed evaluation (qualitative analysis) - scheduled May

Up to 25 students will be asked to participate in individual observed evaluation sessions. In these sessions each student will be asked to login with a selected code (test1n : test25n and test1 : test25). They will be asked to complete one topic revision using the revision Q&A as normal (test1n : test25n) and a different topic revision using their CPLS (test1 : test25). During this session their reactions and answers will be recorded and non-intrusive questions asked from time to time. Their revision results will be logged in the database and will enable a qualitative analysis.

B8. Are any novel procedures involved?

My research indicates that the concept of obtaining the student's Communication Preference and Learning Style BEFORE using a module interface and using these to change the way that interface reacts with the student has not yet been used before.

B9. State the potential hazards, if any, and the precautions to be taken

None - each student is provided with the choice to use the module content without the CPLS test or with it. In the former case a neutral facility is offered, in the latter, the full interactive facility is offered.

B10. State the degree of discomfort in terms of apprehension, pain, stress and disturbance in terms of alteration to routine

None - if the student decides to use the CPLS the test and report takes circa 5 minutes. The observed evaluation will take circa 1 hour.

B11. State your experience or that of the investigator/s in this type of investigation

No particular training except for many psychometric tests undertaken in industry and extensive research.

B12. Names and qualifications of personnel who will be supervising the project

Dr Claude Ghaoui BSc, MSc, PhD, Senior Lecturer in Computer Systems, LJMU

B13. The Ethics Committee needs to know if similar work has been undertaken before:

B13.1 What other work do you know of that has been done in a similar subject area and how does this relate to your proposed programme?

Only Prof. Shaaron Ainsworth work with REDEEM at Nottingham University. In REDEEM the tutor or teacher is asked to enter their own concept of each student's or each student's group style of teaching to be used before the interaction with Questions and Answers starts. Her research indicates that every tutor provides a different teaching style for each subject - the learning styles used are a subjective interpretation of what the tutor considers will match the subject and are not based on any proven approach. Other researches have confirmed that tutors are likely to not be able to accurately state a subject personality type especially when the subject is introverted as compared with extraverted.

B13.2 Please give a brief description of the parts of your study that will be completely original

The concept of obtaining the student's Communication Preference and Learning Style BEFORE using a module interface and using these to change the way that interface reacts with the student has not yet been used.

SECTION C: SUBJECTS

C1.How will the subjects be recruited? (**NOTE**: If subjects are to be approached by letter, you MUST attach a specimen copy to this application)

From existing modules run in the LJMU School of Commuting and Mathematics

C2.Number and type of subjects likely to be involved

Up to 150 students from the HCI modules for the 'unobserved evaluation.' Up to 25 students from the HCI modules for the 'observed evaluation.'

C3.Age range of subjects to be recruited:	As per the module intake 18:40
C4.Are questionnaires to be used in this investigation?	Web Communication Preference & Learning Styles Observed evaluation form
C5.Have they been validated previously?	No

C6.If yes, state by whom and when, (if no, you **MUST** include copies of the questionnaire/s with this application)

C7.Will pregnant women be excluded?	No

C8.State how the subject's informed consent will be obtained (*please tick*):

orally:	yes		no	x
in writing (via recorded web application):	yes	√	no	
in the presence of a disinterested third person:	yes		no	x

C9.If written consent is necessary, please state if form EC3 will be used. If not you **MUST** provide a copy of the consent form.

Normally, consent should be given in writing and witnessed by a disinterested third party unless the applicant can show good reason why this should not be the case.

Consent forms for adults (EC3) and for parents/guardian/carers of children/adults incapable of consent (EC4) are available.

If an alternative consent form is to be used, you MUST attach a specimen copy to this application.

C10.Will the project involve taking (or working with) blood from unscreened volunteers?

yes ☐ no ☒

If yes, please confirm that the applicant has undergone a suitable immunisation programme against hepatitis B (as detailed by JMU Health and Safety Unit).

SECTION D: DECLARATION

D1.Notwithstanding the declaration at the end of this form, has each investigator read, understood and accepted the Liverpool John Moores University Ethics Committee's Regulations and Guidelines?
(Please tick)

yes √ no

(The World Wide Web address for guidance is: http://cwis.livjm.ac.uk/research_and_graduate/regulations/hum_vols/index.htm)

D2.If the investigation is a research degree project, append a copy of the completed Section 4 of the Liverpool John Moores University Research Degree Registration Application

D3.If the investigation is a teaching exercise, append the exact practical schedule as it will be presented to the student

D4.If the investigation is a final year undergraduate project, append an exact copy of the project as presented to the subject.

D5.If the investigation is a research project, append an exact copy of the project as presented to the subject.

D6.**Declaration (to be countersigned by the Director of School)**

I declare that the proposed investigation described in this schedule will be carried out only as described and that at all times the Regulations and Guidelines of the University's Ethics Committee will be adhered to. Before any deviation from the investigation described or from the Ethical Regulations takes place, the written permission of the University's Ethics Committee will be sought.

Applicant's Signature	Director of School's Signature
Date	Date

The completed form should be returned to the Ethics Committee Secretary, Rodney House, 2nd Floor, Liverpool, L3 5UX.

Checklist: Please make sure the following are included in submission
- Copy of Application Form (EC1)
- Relevant Consent Form(s) (EC2), (EC3), (EC4)
- Participant Information Sheet(s) (EC6)
- Copy of questionnaire (if applicable)

Outline of interview (if applicable)

Project Details document

Personal Communication Preference and Learning Styles?

Introduction

WISDeM is being developed to offer a Generic Intuitive Interactive Distance Learning Tool (DLT) for higher education. The whole emphasis of the research is that a Generic Intuitive Interactive Tutoring System should first establish a Student's Profile (his/her Communication Preference and Learning Styles) and automatically map this to the Teaching Styles to be used.

Research Hypothesis

"Matching neurolinguistic programming (NLP) language patterns in an online distance learning tool, with the learner's communication preference and learning styles, will provide an intuitive tutoring system that will enhance Human-Computer Interaction and communication and, thus, enhance the storing and recall of instances to and from the learner's memory; thus enhancing learning".

Student Actions

The student is asked to complete a Communication Preference (CP) questionnaire by selecting only those statements with which he/she agrees. This establishes the student's CP. Using the relevant Neurolinguistic Programming (NLP) Language Patterns for iconic (V), echoic (A) and kinaesthetic (K) types the bi-polar Learning Style (LS) questionnaire establishes the student's rated personality type from one of sixteen types (Extravert or Introvert, Sensing or iNtuition, Thinking or Feeling, and Perception or Judgement). The resultant CPLS is used to change the way the Human Computer Interface interacts with the user in real-time.

Research Basis

(Catania, 1992) reports that sensory input is mainly derived from iconic 60%, auditory 30%, and haptic 10% with little from olfactory and gustatory. (Driscoll & Garcia, 2000; N. Fleming, 2001; N. D. Fleming & Mills, 1998; Fuller et al., 2000; Murphy et al., 2002) show that everyone has his/her own preference for exchanging ideas, acquiring and passing on knowledge. (Sadowski & Stanney, 1999) report that there is a tendency to prefer one sensory input (visual, auditory or kinaesthetic - tactile/haptic) whilst (N. Fleming, 2001)'s research shows that most students prefer multi-modal communication. (Pasztor, 1998a) reports that rapport with a partner is key to effective communication and that incorporating NLP in intelligent agents will allow customisation of the personal assistant to the particular habits and interests of the user thus making the user more comfortable with the system.

WISDeM

WISDeM incorporates: i) *DLT concepts* - the usual DLT components based on ProflexLearn (Claude Ghaoui, 1996/1997), ii) *ITS methodological concept* - based on REDEEM (S. Ainsworth et al., 2002) a developed and tested ITS, iii) *CPLS* provides the psychometric input. IT ALL STARTS WITH THE LEARNER - the development of the initial Student Profile: the way the student Communication Preferences is ascertained and used to determine the students own Learning Styles, and the creation of the initial Student Profile to which Teaching Styles are mapped.

Bibliography

Relevant entries

Bill Janvier

Email: cmswjanv@livjm.ac.uk & bill@janvier.freeserve.co.uk

Evaluation Document - 1st session Evaluation - CPLS & Web Site

To start the evaluation of WISDeM open the WISDeM web site @ http://cmswjanv/janvier/wisdem (intranet)

Login

1. SELECT SCHOOL : select ... Computing and Mathematical Sciences - HCI
2. WISDeM Tutorials : In this front menu page click ... Module Registration
3. COMPLETE REGISTRATION : In 'Entry to Registration' enter
   a. Enter ... the supplied Registration Number
   b. Select ... cd1009 – User Interface Design
   c. Click ... Submit Entry
4. REGISTRATION FORM
   a. FOR THIS EVALUATION ONLY leave the Student Registration Number as given
   b. Complete the balance on the registration form as requested.
   c. Click ... submit
5. CONFIRM REGISTRATION - check that your entries are correct
   a. Click ... Submit Registration
6. MODULES : select CD1009 – User Interface Design
7. LOGON :
   a. At 'Student Registration Number' ... enter your supplied Registration Number
   b. At 'Password' ... enter your password
8. PERSONAL COMMUNICATION et al page
   There are 2 options
   a. OPTION 1 registration number with NO postfix (viz. eval01), select ... YES
   b. OPTION 2 registration number with a postfix (viz. eval01n), select ... NO
   c. **HANDOUT**: You have been handed a copy of the 'Project Details' document.
9. COMMUNICATION PREFERENCE :
   a. Complete this as requested.
10. LEARNING STYLES :
    a. Complete this as requested.
    b. 'Personal Learning Styles Report' ... if you want a copy of this save it or print it, IT WILL NOT be repeated in this form.
11. MODULE FRONT PAGE :
    a. From the left menu frame select ... Revision
12. REVISION QUESTIONS
    a. Select ... Topic Revision
    b. Initially select ... Topic Learning

    When you are ready select ... Topic Testing

This section is to be completed for ALL students.

1. Student Details

No	Question	Answer
1	Enter FIRST registration reference (viz. eval01 or eval01n).	
2	What is your age?	
3	What is your sex? (m|f)	
4	What degree course are you taking?	
5	What year are you in?	
6	Do you have any experience with computer multi-choice Q&As?	

This section is to be completed for ALL students.

2. Registration - Logon - Module Entry

No	Question	Rating (1 poor - 10 very good)
7	Do you consider that **registration** was easy?	
	Is there any part that you consider could be improved?	
8	Do you consider that **logon** was easy?	
	Is there any part that you consider could be improved?	
9	Do you consider that **Module Entry** was easy?	
	Is there any part that you consider could be improved?	
	Are there any other comments that you would like to make?	

If evaluation is for 'N' type students, go to page 6

This section is to be completed ONLY for CPLS students.

3. Communication Preference

No	Question	Rating (1 poor - 10 very good)
10	Do you consider that this CP matches your own ideas?	
11	Was this section easy to complete?	
	Is there any part that you consider could be improved?	
	Are there any other comments that you would like to make?	

This section is to be completed ONLY for CPLS students.

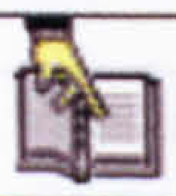
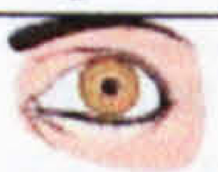
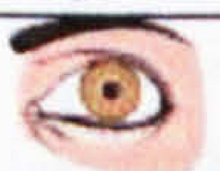
4. Learning Styles

No	Question	Rating (1 poor - 10 very good)
12	Do you consider that these LS match your own ideas?	
13	Was this section easy to complete?	
14	Did the report adequately reflect your input?	
15	Overall was the sequencing well presented?	
16	Overall did the Human Computer Interface act as expected?	
17	Overall was the use of colour and presentation up to HCI standards?	
	Is there any part that you consider could be improved?	
	Are there any other comments that you would like to make?	

Now go to page 7

This section is to be completed ONLY for NON-CPLS students.

5. Neutral Evaluation

No	Question	Rating (1 poor - 10 very good)
18	How intuitive did the student find the interface?	
	Did the student find any problems using the web site?	
19	Was understanding and comprehension demonstrated?	
20	Was the flow seen to be as planned?	
21	Did the student understand the facilities offered?	
22	Was the use of screen language correct for the student?	
23	How many times was each facility used in the **Learning** section?	
	Topic No. Hyperlink:	
24		
25		
26	**Next Question**	
27	**Help FAQs**	
	How many times was each facility used in the **Topic Testing** section?	
28		
29		
30	**Submit Answer**	
31	**Correct Answer**	
32	**Restart Topic/Revision**	
33	**Next Question**	
34	**Analysis Report**	
35	**Help FAQs**	
36	Revision Question Answers	

Now go to page 9

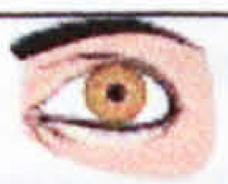
This section is to be completed for CPLS students.

6. CPLS Evaluation - part 1

No	Question	Rating (1 poor - 10 very good)
37	How intuitive did the student find the interface?	
38	Did the use of CP messaging seem to be accepted and read?	
39	Did the use of LS messaging seem to be accepted and read?	
	Did the student find any problems using the web site?	
40	Was understanding and comprehension demonstrated?	
41	Was the flow seen to be as planned?	
42	Did the student understand the facilities offered?	
43	Was the use of screen language correct for the student?	
44	Did the prefix language seem correct and observed by the student?	
45	Were prefix messages observed by the student?	
46	Did the motivational feedback messages seem correct for the student?	
47	Were feedback prefix messages observed by the student?	

This section is to be completed for CPLS students.

6. CPLS Evaluation - part 2

	How many times was each facility used in the **Topic Learning** section?
49	Topic No. Hyperlink:
50	
51	
52	**Next Question**
53	**Help FAQs**
54	How many times was each facility used in the **Topic Testing** section?
55	
56	Personal Study Advice:
57	
58	
59	Change Feedback Response:
60	Header Messages:
61	Answer Feedback:
62	Statistical Report:
63	**Submit Answer**
64	**Correct Answer**
65	**Restart Topic/Revision**
66	**Next Question**
67	**Analysis Report**
68	**Help FAQs**
69	Revision Question Answers

Now go to page 10

This section is to be completed by ALL students AFTER both Topic Learning and Testing are completed.

7. Neutral Comparative Student Feedback

No	Question	Rating (1 poor - 10 very good)
70	Did you like using the **topic learning** section?	
71	Did you find the **topic learning** section useful?	
	What did you find most useful about this **topic learning** section?	
	Which did you find the most useful to you the non-interactive (n) or the interactive (cp) & why?	
	What improvements could be made to **topic learning** to make this more helpful to you?	
72	Did you like using the **topic testing** section?	
73	Did you find the **topic testing** section useful?	
	What did you find most useful about this **topic testing** section?	
	What improvements could be made to **topic testing** make this more helpful to you?	
	Which did you find the most useful to you the non-interactive (n) or the interactive (cp) & why?	

Now go to page 11

This section is to be completed by ALL students AFTER both Topic Learning and Testing are completed.

8. CPLS Comparative Student Feedback

No	Question	Rating (1 poor - 10 very good)
74	Did you like using the **topic learning** section?	
75	Did you find the **topic learning** section useful?	
	What did you find most useful about this **topic learning** section?	
	Which did you find the most useful to you the non-interactive (n) or the interactive (cp) & why?	
	What improvements could be made to **topic learning** to make this more helpful to you?	
76	Did you like using the **topic testing** section?	
77	Did you find the **topic testing** section useful?	
	What did you find most useful about this **topic testing** section?	
	What improvements could be made to **topic testing** make this more helpful to you?	
	Which did you find the most useful to you the non-interactive (n) or the interactive (cp) & why?	

This section is to be completed by ALL students AFTER both Topic Learning and Testing are completed.

9. Comparative Student Feedback for both N & CPLS

No	Question
	Which interfaces did you prefer the non-interactive (n) or the interactive (cp) & why?
	Which interfaces would you use the non-interactive (n) or the interactive (cp) & why?
	Which interfaces do you consider would help you to remember and recall information from your memory - the non-interactive (n) or the interactive (cp)?
	What overall comments would you like to make of your experience?

Evaluation Document - 2nd session - Group Evaluation for CPLS

Evaluation Number			Time
Communication Preference (CP)		Start CP	
Learning Styles (LS)		Start LS	
	Enter types	Completed at	

To start the evaluation of WISDeM open the WISDeM web site @ http://cmswjanv/janvier/wisdem

Login

1. SELECT SCHOOL : select ... **Computing and Mathematical Sciences - HCI**

2. WISDeM Tutorials : In this front menu page click ... **Module Registration**

3. COMPLETE REGISTRATION : In 'Entry to Registration' enter
   Enter ... the supplied Registration Number (e.g. e001)
   Select ... **cd3001 - User Interface Design**
   Click ... Submit Entry

4. REGISTRATION FORM
   FOR THIS EVALUATION ONLY leave the Student Registration Number as given (e.g. e001)
   Complete the balance on the registration form as requested.
   Click ... submit

5. CONFIRM REGISTRATION - check that your entries are correct
   Click ... Submit Registration

6. MODULES : select **CD3001 - User Interface Design**

7. LOGON :
   At 'Student Registration Number' ... enter your supplied Registration Number
   At 'Password' ... enter your password

8. PERSONAL COMMUNICATION et al page
   HANDOUT: You have been handed a copy of the 'Project Details' document.
   There are 2 options, select 1 unless you do not wish to complete the psychological questionnaire
   OPTION 1 select ... YES
   OPTION 2 select ... NO

9. COMMUNICATION PREFERENCE :
   Complete this as requested

10. LEARNING STYLES :
    Complete this as requested.
    'Personal Learning Styles Report' ... if you want a copy of this save it, IT WILL NOT be repeated in this form.

11. MODULE FRONT PAGE :
You now have opened the module facilities; however, no tutorial information has been added, this will be available NEXT week.

This section is to be completed for ALL students.

1. Student Details

No	Question	Answer
1	Enter **FIRST** registration reference (viz. **eval01** OR **eval01n**)	
2	What is your age?	
3	What is your sex? (m|f)	
4	What degree course are you taking?	
5	What year are you in?	
6	Do you have any experience with computer multi-choice Q&As?	
	If so, give brief details.........	

This section is to be completed ONLY for CPLS students.

2. Communication Preference

No	Question	Rating (1 poor - 10 very good(
7	Do you consider that this **Communication Preference** matches your own ideas?	
8	Was this section easy to complete?	
	Is there any part that you consider could be improved?	
	Are there any other comments that you would like to make?	

This section is to be completed ONLY for CPLS students.

3. Learning Styles

No	Question	Rating (1 poor - 10 very good)
9	Do you consider that these **Learning Styles** match your own ideas?	
10	Was this section easy to complete?	
11	Did the report adequately reflect your input?	
12	Overall was the sequencing well presented?	
13	Overall did the Human Computer Interface act as expected?	
14	Overall was the use of colour and presentation up to HCI standards?	
	Is there any part that you consider could be improved?	
	Are there any other comments that you would like to make?	

This section is to be completed for ALL students.

4. Registration - Logon - Module Entry

No	Question	Rating (1 poor - 10 very good)
15	How easy was it to complete **Registration?**	
	Is there any part that you consider could be improved?	
16	How easy was it to **Logon?**	
	Is there any part that you consider could be improved?	
17	How easy was it to enter your chosen **Module?**	
	Is there any part that you consider could be improved?	
	Are there any other comments that you would like to make?	

IF CPLS student - GOTO page 1 and complete the Statistical table

Evaluation Document - 2 session - Group Evaluation for Web Site

Evaluation Number		**n-MOD Mark**	
Start 1st Part		**n-CAB Mark**	
Start 2nd Part		**cpls-MOD Mark**	
Completed at		**cpls-CAB Mark**	

To start the evaluation of WISDeM open the WISDeM web site @ http://cmswjanv/janvier/wisdem (intranet)

Login

1. SELECT SCHOOL : select ... Computing and Mathematical Sciences - HCI

2. WISDeM Tutorials : In this front menu page
   click ... **List of Modules or Module Entry**

3. MODULES : select **CD3001 - User Interface Design**

4. LOGON :
   At 'Student Registration Number' ... enter your supplied Registration Number
   At 'Password' ... enter your password

5. MODULE FRONT PAGE :
   From the left menu frame select ... Revision

6. REVISION QUESTIONS
   Select ... Topic Revision
   Initially select ... Topic Learning

   When you are ready select ... Topic Testing

Evaluator

Your subject can be running the:
CONTROL evaluation first
OR
INTERACTIVE (CPLS) evaluation first.

CONTROL evaluation — **GOTO page 2 to start**

INTERACTIVE (CPLS) evaluation — **GOTO page 4 to start**

1. Control Evaluation - Part 1

No	Question	Number Used
	TOPIC LEARNING - How many times was each facility used?	**CONTROL ONLY**
TL01n	**Topic No. Hyperlinks:**	
TL02n	**Bibliography:**	
TL03n	**Image Link:**	
TL04n	**Next Question**	
TL05n	**Help FAQs**	
	TOPIC TESTING - How many times was each facility used?	**ALL Students**
TT01n	***Menu* MainTopics:**	
TT02n	***Menu* Revision:**	
TT03n	**Description of facilities:**	
TT04n	**Bibliography:**	
TT05n	**Image Link:**	
TT06n	**Submit Answer**	
TT07n	**Correct Answer**	
TT08n	**Restart Topic/Revision**	
TT09n	**Next Question**	
TT10n	**Analysis Report**	
TT11n	**Help FAQs**	
TT12n	**Revision Question Answers**	

GOTO Next Page

2. CONTROL Evaluation - Part 2

	Topic Learning (Control evaluation ONLY)	Rating (1L-10VG)
18	How intuitive did the student find the interface?	
19	Was understanding and comprehension demonstrated?	
20	Was the flow seen to be as planned?	
21	Did the student understand the facilities offered?	
22	Did the student find answer feedback useful?	
	Topic Testing (ALL evaluations)	**Rating (1L-10VG)**
23	How intuitive did the student find the interface?	
24	Was understanding and comprehension demonstrated?	
25	Was the flow seen to be as planned?	
26	Did the student understand the facilities offered?	

IF CONTROL EVALUATION GOTO Next Page

IF INTERACTIVE (CPLS) EVALUATION GOTO Page 6

3. CPLS Evaluation - Part 1

No	Question	Number Used
	TOPIC LEARNING - How many times was each facility used?	**CPLS ONLY**
TL01	**Topic No. Hyperlinks:**	
TL02	**Bibliography:**	
TL03	**Image Link:**	
TL04	**Next Question**	
TL05	**Help FAQs**	
	TOPIC TESTING - How many times was each facility used?	**ALL Evaluations**
TT01	***Menu* MainTopics:**	
TT02	***Menu* Revision:**	
TT03	**Description of facilities:**	
TT04	**Bibliography:**	
TT05	**Image Link:**	
TT06	**Submit Answer**	
TT07	**Correct Answer**	
TT08	**Restart Topic/Revision**	
TT09	**Next Question**	
TT10	**Analysis Report**	
TT11	**Help FAQs**	
TT12	**Revision Question Answers**	
TT13	**Header Messages (top Link - if shown)**	
TT14	**Change Feedback Response**	
TT15	**Header Messages**	
TT16	**Answer Feedback**	
TT17	**Statistical Report**	

GOTO Next Page

4. CPLS Evaluation - Part 2

	Topic Learning (CPLS evaluations ONLY)	Rating (1L-10VG)
27	How intuitive did the student find the interface?	
28	Was understanding and comprehension demonstrated?	
29	Was the flow seen to be as planned?	
30	Did the student understand the facilities offered?	
	Topic Testing (ALL evaluations)	**Rating (1L-10VG)**
31	How intuitive did the student find the interface?	
32	Was understanding and comprehension demonstrated?	
33	Was the flow seen to be as planned?	
34	Did the student understand the facilities offered?	
35	How useful was the Header Messages section?	
36	Did the student see the Q&A prefixes?	
37	How useful were the Q&A prefixes?	
38	How useful were the Feedback sections?	
39	How useful was the 'Change Feedback Response' link and page?	
40	How useful was the 'Header Messages' link and page?	
41	How useful was the 'Answers Feedback' link and page?	
42	How useful was the 'Statistical Report' link and page?	

IF INTERACTIVE (CPLS) student GOTO Page 2

IF CONTROL student GOTO NEXT PAGE

This section is to be completed for ALL students AFTER both CONTROL and INTERACTIVE evaluation sections have been completed.

5. Comparative Student Feedback

No	Question
CSF01	Which did you find the most useful to you the non-interactive (n) or the interactive (cp) & why?
CSF02	Which interfaces did you prefer the non-interactive (n) or the interactive (cp) & why?
CSF03	Which interfaces would you use the non-interactive (n) or the interactive (cp) & why?
CSF04	Which interfaces do you consider would help you to remember and recall information from your memory - the non-interactive (n) or the interactive (cp)?
CSF05	What overall comments would you like to make of your experience?

GOTO Page 1 to complete the Statistical table.

INDEX page