Creation and Evaluation of *AnswersIn*, a Novel Computer Based Teaching Framework in Gastroenterology

MD Thesis

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Declaration

I hereby declare that the contents of this thesis are the result of my own work.

Signed:

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Thesis Abstract

Background: There is currently little evidence of a theoretical base for the development and delivery of multimedia teaching in medicine. In this thesis I have; (1) reviewed the principles of adult learning and Instructional Design (ID) (2) proposed an evidence based model for a novel multimedia learning framework (3) developed the model (4) delivered the program to medical students who evaluated its functionality and content and (5) identified learning points for future investigators.

Method: Interview style scripts were authored, recorded and integrated to produce "*AnswersIn* Gastroenterology". A focus group based pilot study tested the robustness of the program and need for modification. Following a survey of medical student access to multimedia computers, *AnswersIn* was made available on the university server. The technical challenges of web-delivery were documented and the program made available to four consecutive student groups during their gastroenterology blocks. At the end of each block, students formatively evaluated the resource via a questionnaire. Additionally, the variety of data available using a web-tracker was examined as well as the effect upon usage of a series of advertising emails.

Results: 8.5 hours of content were developed. The focus group recommended modifications which were implemented. The survey demonstrated that medical students have high levels of access to multimedia computers. Despite problems encountered during the implementation phase, a total of 178 students had access over four blocks. 21 percent considered *AnswersIn* as an alternative to lectures and 33 percent indicated that they would use *AnswersIn* as their main learning resource. Students gave reasons why they continued to favour traditional teaching methods but almost all stated that they would like to see *AnswersIn* extended to other subjects.

Web tracking demonstrated that advertising increased usage.

Conclusion: *AnswersIn* is a novel framework formulated using principles of adult learning and Instructional Design. Formative assessments indicate that students respond favourably to its introduction and its usage can be influenced by advertising.

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Glossary of Terms

Blended Learning- The combination of multiple approaches to learning, usually taken to mean traditional learning methods in addition to Computer Aided Learning.

Blog- Web Log

CAI- Computer Aided Instruction

CAL- Computer Aided Learning

CBL- Computer Based Learning

CLAIT- A qualification designed to recognise the skills, knowledge and understanding of IT users in employment, education or training

ECDL- European Computer Driving Licence

EWTD- European Working Time Directive

Files- The total number of hits (requests) that actually result in something being sent back to the user

GHEDNOH- Gastroenterology, hepatology, endocrinology, diabetes, nephrology, oncology & haematology- A third year study module

Hits- The total number of requests made to the server during the given time period (month, day, hour etc)

IT- Information Technology

Kilobyte (KB) - This is 1024 bytes. A measure used to show the amount of data that was transferred between the server and the remote machine, based on the data found in the server log.

OSCE- Objectively Structured Clinical Examination

Pages- These are the URLs that would be considered the actual page being requested, and not all of the individual items that make it up (such as graphics and audio clips).

PBL- Problem Based Learning

RFUCMS- Royal Free & University College Medical School

RLO- Reusable Learning Object

SDL- Self Directed Learning

Sites- The number of unique IP addresses/hostnames that made requests to the server

Visits- A visit is logged when a remote site makes a request ("hit") for a page on a server for the first time. As long as the same site keeps making requests within a given timeout period, they will all be considered part of the same visit

URL- Uniform Resource Locator, the global address of documents and other resources on the World Wide Web

VLE- Virtual Learning Environment

WBL- Web Based Learning

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Dedication

To Kate and Aram. Thank you for being my world

To my parents, Qamar and Najma and to my brother and sister, Najeeb and Serena

To my students

Chapter 1- Introduction

Overview

Medical education in the UK is evolving.

For much of the last century the university curriculum in medicine was delivered in the lecture theatre and at the bedside. Great emphasis was placed on lecture attendance, absorption of a large number of facts and this was usually followed by some form of clinical apprenticeship .Over the last few decades, medical educators have been introduced to modern concepts of evidence based learning and evidence based practice and these frameworks have driven a rapidly evolving change in medical school curriculum development. In addition, further evolutionary pressures have been placed on UK medical schools. These include:

- An increase in the number of medical school places[1]
- A relative decrease in the number of clinical teachers[2]
- Decreased availability of clinical teachers due to the European Working Time Directive (EWTD)
- Rising expectations of students who now pay tuition fees
- Changes in clinical placements with much of the delivery of learning in primary care and District General Hospitals
- An emphasis on problem-based rather than factual learning
- A switch from discrete subject-based teaching in anatomy, physiology, pathology and microbiology to an integrated format based on early exposure to clinical practice

These and other factors have resulted less contact between student and teacher with less time devoted to the delivery of core factual information, once thought essential for the training of a doctor. The rapid changes occurring in medical education have coincided with a revolution in communication. Just as the development of the printing press freed individuals from dependence on the spoken word, the personal computer (PC),the Internet and the mobile cell-phone have offered unrestricted freedom, for individuals from all walks of life, to communicate using sound and vision in a manner undreamed of even a decade ago.

This thesis sets out to explore the potential for the revolution in information delivery and in particular, multimedia, to converge with the principles of Instructional Design (ID), and deliver excellent learning in an era of contracting human resources in medical schools.

There is a large body of literature about computer aided learning (CAL) and most conclude that CAL is not superior to traditional teaching methods such as the lecture. These studies may miss the point that CAL need not be superior and that demonstrating equivalence may be enough to justify introducing such programmes[3]. Indeed, despite its apparent potential and considerable effort given to the development of CAL in primary, secondary and tertiary education since the development of modern computers, CAL has not borne much fruit, and to date, no medical school has succeeded in placing CAL at the epicentre of the learning experience.

In medical schools, CAL remains a bit-part player in the curriculum. Development is usually piecemeal, led by enthusiasts and early adopters, and whilst there are many isolated examples of excellence, lectures, seminars, books and handouts remain the core delivery methods in most of the world's undergraduate medical schools. Enthusiasts soon learn that the development of multimedia is time consuming, costly and equivalent to a movie production requiring script-writers, audio and video media production departments, animation and sound studios and added to this is the time consuming process of content integration.

In this thesis I propose to examine the following areas:

- Current theories pertaining to how adults learn, the principles of Instructional Design (ID) and how these may be translated into the framework of a multimedia CAL platform using the **ADDIE** (**Analysis, Design, Development, Implementation, Evaluation**) model
- The published literature on CAL interventions within the undergraduate medical environment both in terms of comparative studies and descriptive studies of implementation initiatives (**Analysis**)
- The extent to which medical students have access to multimedia equipment both at home and in their place of study as well as their degree of familiarity with e-learning resources (**Analysis**)
- Use of ID and Multimedia Principles to guide the development of a novel CAL platform called "*AnswersIn"* which is designed to provide a "learning on demand" syllabus covering core topics in gastroenterology and delivered both on CD-ROM and using the Internet (**Design & Development**)

- Pilot testing of *AnswersIn* and the initial responses of a selected group of students (**Evaluation** & Rapid Prototyping)
- Introduction of *AnswersIn* to the local curriculum using the university intranet and electronically assessing usage (**Implementation**)
- The impact of using "push" technology to encourage uptake of the *AnswersIn* module by sending a weekly email advertising the module (**Evaluation**)
- The logistics of introducing the *AnswersIn* module across all 3 Medical School campuses at UCL and monitoring uptake (**Implementation**)
- Identification of problems and challenges encountered in the delivery of a multimedia CAL module into the medical school and outline how this may help inform others who propose similar interventions in centres of learning (**Evaluation**)
- Establishment of the place that *AnswersIn* may have in a future blended curriculum

Hypothesis

The central hypothesis is:

***AnswersIn*, an asynchronous learning multimedia CAL program built using the principles of Instructional Design and Adult Learning, is a feasible, accessible and acceptable means of teaching core topics in gastroenterology to 3rd year medical students**

Research Questions

The research questions generated by this hypothesis are:

1. What constitutes "Adult Learning"?
2. To what extent can the principles of adult learning and Instructional Design (ID) be incorporated into the design and content of a computer based instructional resource for clinical medical students?
3. What access do medical students have to equipment that would allow them to access such multimedia learning resources?
4. What is involved in the development of a suitable multimedia learning resource?
5. What methods can be implemented in order to evaluate student responses to this resource?
6. What are the logistics involved in providing this resource to defined populations of students?
7. How can uptake of the resource be monitored and what is the effect of advertising on uptake of the resource?
8. What common challenges might be faced by others attempting to introduce CAL initiatives into a medical curriculum based on our experiences?

Finding a definition of learning

Before attempting to define learning it is important to draw attention to the perceived difference between learning and education:

"Education is an activity undertaken or initiated by one or more agents that is designed to effect changes in the knowledge, skill and attitudes of individuals, groups or communities. The term emphasises the educator (teacher), the agent of change who presents stimuli and reinforcement for learning and designs activities to induce change.

The term learning, by contrast, emphasises the person (the learner) in whom the change occurs or is expected to occur. Learning is the act or process by which behavioural change, knowledge, skills and attitudes are acquired"[4]

Defining the term "learning" is difficult due to its protean nature. Smith eloquently identifies the problem with the following comments:

"Learning is used to refer to:

- *The acquisition and mastery of what is already known about something*
- *The extension and clarification of meaning of one's experience or*
- *An organized, intentional process of testing ideas relevant to problems*

In other words, it is used to describe a product, a process or a function"[5]

Others such as Hilgard suggest that definition is not key to understanding learning but rather the emphasis should be put on interpretation[6].

The following list of definitions illustrates the fact that our most distinguished learning theorists can hold a variety of differing views on what appears to be, on the face of it, a simple concept:

- *"Learning involves change. It is concerned with the acquisition of habits, knowledge and attitudes. It enables the individual to make both personal and social adjustments. Since the concept of change is inherent in the concept of learning, any change in behaviour implies that learning is taking place*[7]*."*
- *"Learning is the process whereby knowledge is created through the transformation of experience*[8]*."*
- *"Learning is a change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth*[9]*."*

In the third definition, Gagne encapsulates his "*information processing*" model of learning where the event of learning has constituent parts i.e. a learner, a situation, the learner's memory and their response to the situation in hand. The focus is on the outcome of the interplay of these factors.

By contrast, the second definition is ascribable to Kolb who suggests that learning is a holistic process based on experience, and requires resolution of different ways of looking at the world involving transactions between the learner and the environment. Here the focus is very much on describing the process of change. By and large Kolb's work has been more influential and can be seen to underlie many contemporary ideas on what constitutes good teaching practice.

In 1979 Säljö[10] asked a number of adult students what they understood by learning. Their responses fell into five main categories:

- Learning as a quantitative increase in knowledge. Learning is acquiring Learning information or 'knowing a lot'.
- Learning as memorising. Learning is storing information that can be reproduced.
- Learning as acquiring facts, skills, and methods that can be retained and used as necessary.
- Learning as making sense or abstracting meaning. Learning involves relating parts of the subject matter to each other and to the real world.
- Learning as interpreting and understanding reality in a different way. Learning involves comprehending the world by reinterpreting knowledge.

Contrast the first three definitions which are rather simplistic and "external" with the latter two which deal more with learning as an "internal" or "personal" phenomenon. In essence, the system of categories shown above can be seen as hierarchical, the later definition encompassing the one that has gone before.

Students who conceive of learning as understanding reality are also able to see it as increasing their knowledge[11].

Learning in the context of growth is another arena of debate when definitions are being debated. Most learning theorists including Gagne see learning as "*a change in human disposition or capability which can be retained and which is not simply ascribable to the process of growth.*"[12]

Others consider growth to be integral to any definition of learning. Bruner states that *"there are so many aspects of growth that any theory (of learning) can find something that it (growth) can explain well"*[13]

What emerges from the above is the notion that the definition of learning depends upon who is asked.

Pedagogy in Perspective

The word 'pedagogy' has Greek roots, originally meaning 'a slave who took a boy to and from school'. It is a combination of the Greek words for boy (*paidos*) and leader (*agogos*). Thus, in its original definition, pedagogy refers to a leader of children. Although pedagogy is a somewhat archaic word that initially dealt with the instruction of children (and tellingly emphasised the role of the instructor in its very definition), it has been co-opted as an umbrella term for all teaching activities and the theories that underpin them.

Origins

As an ideology, pedagogy has its roots in the sixth and seventh century monastic schools where rote learning of religious scriptures by young boys was generally the sum total of learning activity. This transfer of knowledge from a single individual or book (namely the bible) to the unitiated was not limited to acolytes of the monastery. Much of it spilled over into the sermons preached to willing (and unwilling) masses in search of salvation.

This instructional method was quick to spread over the centuries, across borders and finally make its way to the secular school systems of most western countries where it has remained to this day[14]. Colonial activities of the last 500 years have ensured its place in developing countries as well. Today, the traditional pedagogical model is the dominant teaching philosophy in primary and secondary schools as well as institutions of higher education.

The Traditional Pedagogical Model

According to Knowles there are some key assumptions made about the learner in the traditional pedagogical model[15]:

- **The learner is a dependent personality** - The teacher takes full responsibility for making the decisions about what is to be learned, how and when it should be learned and, afterwards, whether it has been learned. The role of the learner is to carry out the teacher's instructions.
- **The learner's experience is not considered** -The experience of the teacher is all-important. For that reason a variety of one-way communication strategies are employed, including lectures, textbooks and manuals, and a variety of audio-visual techniques that can transmit information efficiently to the learner so they can benefit from the experience of the teacher i.e. "the sage on the stage".
- **Readiness to learn** – The learner is ready to learn when they are told what they have to learn in order to advance to the next level or get the next job.
- **Orientation to learning**- The student enters into an educational activity with a subject- centred orientation. Learning is a process of acquiring prescribed

subject matter content and learning experiences are organised to reflect the subject matter content.

- **Motivation**- The student is externally motivated to learn primarily by pressures from parents, teachers/trainers, employers, the consequences of failure, grades etc.

As the student matures their need to be self directing and independent in their learning activities increases considerably and brings the student into increasing conflict with the traditional pedagogical model.[16] Thus while, at an early age, pedagogy may be more appropriate as an instructional methodology it becomes less so as time passes.

The Adult Learning Movement

It is clear from the preceding discussion that much of modern teaching, both for adults and children is derived from the classical pedagogical model and that this in turn has its origins in ecclesiastical tradition.

It has not always been thus and history shows us that some ancient cultures focused not on the teaching of children but on the teaching of adults. Consider the following examples:

- The ancient Greeks- Socrates, Plato and Aristotle
- The Romans e.g. Cicero
- The ancient Chinese e.g. Confucius and Lao Tse

What these eminent teachers had in common was that none of them were involved in the instruction of children. All their students were adults and their methods reflected this. They all perceived that learning was a process of active inquiry rather that passive reception and assimilation of information. This is reflected in the well known "Socratic Method"[17] which is a method of philosophical inquiry which Socrates adopted after visiting the Oracle at Delphi.

Typically, the Socratic Method involves two individuals involved in a dialogue with others looking on. One person leads the discussion on a given topic while the other accepts or rejects some of the ideas put forward. In essence:
"A Socratic Dialogue can happen at any time between two people when they seek to answer a question about something answerable by their own effort of reflection and thinking starting from the concrete asking all sorts of questions until the details of the example are fleshed out as a kind of platform for reaching more general judgments"[18]

This method was taken forward by the Romans who adopted a more confrontational style where members of the group were required to take a position on a subject and defend it.

Another method of adult instruction that has ancient origins (probably from Chinese and Hebrew sources) is Case Method teaching[19]. Here, a nominated leader describes a real life situation from which a problem arises allowing the group to explore the problem and put forward possible solutions.

The 20th Century and the rebirth of adult learning

It was not until the end of the second world war that the notion arose that not only could adults be taught effectively but that they might learn in ways that differed from children.

While Edward Thorndike was pursuing a "scientific behaviourist" theory of how adults learn Eduard Lindeman was more interested in the process of adult learning which he expounded upon in his seminal work The Meaning of Adult Education which was published in 1926.[20]

Lindeman's view of adult education is reflected in the following quote from a paper he published around the same time:

"*A cooperative venture in non-authoritarian, informal learning, the chief purpose of which is to discover the meaning of experience; a quest of the mind which digs down to the roots of the preconceptions which formulate our conduct; a technique of learning for adults which makes education coterminous with life and hence elevates living itself to the level of adventurous experiment*[21]"

It was Lindeman who first postulated a coherent theory of learning that applied specifically to adults. This theory is based on a well recognised set of key assumptions that underpinned his work and much of the work of those who followed him:

- Adults are motivated to learn as they experience needs and interests that learning will satisfy.
- An Adults' orientation to learning is life-centered.

- Experience is the richest source for an adult's learning.
- Adults have a deep need to be self-directing.
- Individual differences among people increase with age[22]

While studying for his PhD in adult education, Allen Tough was influenced by Cyril Houle who was performing small group experiments which aimed to look at why adults learn. Houle came up with 3 basic types of learner:

- The *goal oriented* learner who used education to achieve clear cut objectives.
- The *activity oriented* learner who enjoyed the learning environment more than the actual course content.
- The *learning oriented* learner who sought knowledge for its own sake[23].

Placing more emphasis on how adults learn than why, Tough discovered that adult learning was a very pervasive activity that came from a wide variety of sources. He divided the adult learning process into a series of discrete episodes which he termed "*projects*" which the average adult undertook on their own in most cases. These projects were planned without the aid of a teacher but the organisation of the components was remarkably similar:

"In most curriculum models, the steps taken by the professional educators include setting the learning goals or objectives, finding resources, choosing the right method and evaluating the progress. It turned out that these steps are exactly what the learners went through. They set their own

goals, they figured out how to learn as they went along, they went and got resources, and they evaluated their progress.[24]*"*

In addition, Tough was fascinated by the motivations of these adult learners and found that the above steps were driven by a wide variety of anticipated benefits and rewards including enjoyment of the learning activity, satisfaction of curiosity, developing a skill or to be better prepared for a similar situation in the future[25]

Introducing Andragogy

"Andragogy assumes that the point at which an individual achieves a self-concept of essential self-direction is the point at which he psychologically becomes adult. A very critical thing happens when this occurs: the individual develops a deep psychological need to be perceived by others as being self-directing. Thus, when he finds himself in a situation in which he is not allowed to be self-directing, he experiences a tension between that situation and his self-concept. His reaction is bound to be tainted with resentment and resistance.

It is my own observation that those students who have entered a professional school or a job have made a big step toward seeing themselves as essentially self-directing. They have largely resolved their identity-formation issues; they are identified with an adult role. Any experience that they perceive as putting them in the position of being treated as children is bound to interfere with their learning."[26]

Origins

In contrast to pedagogy which, as we discussed earlier, refers to the "leading of children" the term Andragogy specifically refers to adults.

The origin of the term is unclear but most attribute its first usage to 1833 by a German educator by the name of Alexander Kapp[27]. The term, along with pedagogy, was subsequently used widely in eastern bloc countries under the umbrella term of "anthropogogy"[28].

Eduard Lindeman was the first western educator to refer to Andragogy in a published work in 1926[29] although this erroneously attributes the coining of the term *"andragogik"* to Eugene Rosenstock of the Frankfurt Academy.

It was not until 1968 with Knowles seminal publication *Androgogy* (sic) *not Pedagogy*[30] that the term came into widespread use. It is with Malcolm Knowles, too, that the term Andragogy has become almost synonymous.

Drawing on the work of predecessors such as Lindeman and Dewey, Malcolm Knowles derived a set of assumptions about adult learners that would see him become one of the most prominent (and controversial) adult educators of the twentieth century. Indeed, his work underpins most contemporary work in the field of adult education as well as adult curriculum development.

Knowles' Key Andragogical Assumptions

The key assumptions that Knowles made about adult learners are[31]:

- **The need to know**- adult learners need to know why they need to learn something before undertaking the learning task. As noted by Tough in 1979, the adult learner is able and willing to expend considerable resources on a learning project if they think the effort will be rewarded with an outcome of sufficient value[32].
- **Learner self-concept** - adults need to be responsible for their own decisions and to be treated as capable of self-direction. Once this concept of responsibility is established, the need for being viewed as self-directing by others becomes deeply rooted. There is subsequent resistance to any attempt to impose the will of another into their schema. Exposure to the "classroom" and "teachers" may only serve to make the adult learner recollect their schooldays when they had no control over their learning and subsequently cause them to resist learning. Use of a learners experience is a means of circumventing this.
- **Role of learners' experience** —adult learners have life experiences which provide an important resource for learning. Certainly the breadth and depth of experience will be far greater than their child counterpart and will make each learner more "individual". Thus the greatest rewards will arise from learning activities that tap into the individual experiences of the learner. The corollary to this is that with experience comes bias and preconception. In either case the learner feels that they are defined by their experiences. Rejection of their experiences is seen as a rejection of the learner.

- **Readiness to learn** —adults are ready to learn those things they need to know in order to effectively deal with life situations. Leading on from experience is the importance of timing. An adult is more ready to learn when the learning exercise is pertinent to their level of development e.g. a teenager will more readily take classes on learning to drive than classes on organising one's finances.
- **Orientation to learning** —adults are motivated to learn to the extent that they perceive that it will help them perform tasks they confront in their life situations. In contrast to children whose orientation to learning is "subject centred", adults orientation to learning is "life centred" (or task/problem centred). Adults learn best when the learning exercise is in some way a simulation of a situation that is likely to be encountered in real life e.g. good English grammar should not be taught purely for its own sake but rather as a means of constructing a competitive curriculum vitae.
- **Motivation**- Adults are internally motivated. While external motivators such as exams, promotions etc. are still strong incentives to engage in relevant learning activity, the most potent adult motivators are those that arise internally such as the desire to do a good job for personal satisfaction, self esteem etc.

Andragogy Vs Pedagogy

We can see from the above assumptions that clear lines can be drawn between classical pedagogy and Andragogy (Table 1.1): [33]

	Pedagogy	Andragogy
The learner	*Dependent.* Teacher directs what, when, how a subject is learned and tests that it has been learned	*Moves towards independence*. *Self-directing.* Teacher encourages and nurtures this movement
The learner's experience	*Of little worth.* Hence teaching methods are didactic	*A rich resource for learning.* Hence teaching methods include discussion, problem-solving etc.
Readiness to learn	*People learn what society expects them to.* So that the curriculum is standardized.	*People learn what they need to know,* so that learning programmes organised around life application.
Orientation to learning	*Acquisition of subject matter.* Curriculum organized by subjects.	*Learning experiences should be based around experiences,* since people are performance centred in their learning

Table.1.1- Distinction between andragogy and pedagogy

Although the distinctions are clear, Knowles admits that the applicability of pedagogical techniques to children and Andragogical techniques to adults is not universal. His later work freely concedes (as a result of feedback from various educational institutions) that the Andragogical model works better for some children's activities and the pedagogical model is better for certain adult activities[34]. For example an adult learner, when confronted with completely new concepts (e.g. a computer programming class) will require, at least initially, a pedagogical element to their learning activity. Similarly, a child with suitable experience may require an Andragogical approach.

This empirical variability places the onus on educators to establish what works and when.

Criticisms of Andragogy

Knowles' synthesis of adult learning has drawn a fair amount of criticism over the years, some of which has resulted in a degree of conceptual repositioning:

- It has never been clear whether Andragogy is a theory of learning or a theory of teaching. *"Has Knowles provided us with a theory or a set of guidelines for practice? The assumptions can be read as descriptions of the adult learner... or as prescriptive statements about what the adult learner should be like?"*[35]
- Knowles' assumptions draw extensively from the work of humanistic psychologists such as Carl Rogers but are also greatly influenced the work of earlier behaviourists e.g. in the example of "conditioned" avoidance of prescriptive learning techniques. This suggests that Andragogy does not sit comfortably in any one conceptual framework[36].
- The assumption that adults are primarily internally motivated has very little experimental data to support it. The number and significance of external motivators and their susceptibility to being overridden by internal motivators is a phenomenon that does not lend itself well to any form of quantification.
- Andragogic practice emphasises the utility of learning from ones peers as opposed to a central authority figure ("the sage on the stage") thus avoiding the problems of possible resentment of authority. The risk in this strategy is that learning becomes inefficient and that there difficulty in achieving standardised teaching.

- The experiential evidence that Knowles alludes to in his revised work shows that children may benefit from Andragogical techniques and adults may appreciate a pedagogical approach under certain circumstances. This may lead to the accusation that andragogy is simply a good way of doing things under certain circumstances regardless of age. Thus it ceases to be a theory of *adult* learning.
- Andragogy as a concept may be culturally bound insofar as it is built upon ideas of self image that arise from North American and European origins.

Many theorists believe the andragogy-pedagogy classification is not perfect, but they cannot agree on a viable alternative either.

Computers and Andragogy

*"**Learning Objects** are defined here as any entity, digital or non-digital, which can be used, re-used or referenced during technology supported learning. Examples of technology supported learning include computer-based training systems, interactive learning environments, intelligent computer-aided instruction systems, distance learning systems, and collaborative learning environments. Examples of Learning Objects include multimedia content, instructional content, learning objectives, instructional software and software tools, and persons, organizations, or events referenced during technology supported learning"*[37]

In 1989 Knowles commented that he saw "*technology mediated learning"* as being one of the major forces that would shape adult learning in the 21st century and would provide adults with "*rich learning experiences in the Andragogical tradition*"[38]. He felt that technology mediated learning (or Computer Aided Learning- CAL) would have the potential to adhere to the core tenets of the Andragogical model:

- A well developed application (or *"learning object*") would incorporate the learner's prior experience i.e. the learner could choose the learning object that best suited their individual level of expertise through the availability of "alternative paths" and through *reflective learning.*[39]
- A well developed learning object would allow the learner to tailor their learning activity towards the resolution of their real world problems and challenges.
- Most significantly, learning objects could be designed to fulfil the adult need to be self-directing. Technology is a perfect path towards the facilitation of self-direction. Such learning objects could have the following features:

1. Non-linear structure where the learner may skip sections, view them in a different order or pause and repeat sections ad infinitum in order to better assimilate difficult conceptual material.
2. Facility to access the object at a time and place of the learner's choosing rather than at the convenience of the instructor.
3. Learning objects have the potential to be formulated in a "just in time" and "just enough" format under conditions of full learner control.[40]

Such developments have indeed come to pass with the advent of CAL and the introduction of myriad learning objects into the environment of the learner. This has brought its own special challenges too. The provision of many facts over the internet and other resources does not equal effective learning for a number of reasons:

- The accessible information available is not always reliable and the reliable information is not always accessible (or sometimes affordable)
- Motivation is not to be confused with self-direction: The student outside the environment of the classroom may begin to behave in an altogether more "pedagogical" manner and choose not to learn for himself
- The learning objects may not of themselves be of sufficiently high quality (regardless of factual accuracy) to engage the target learner. The shortfall may be in the form of usability, accessibility, cosmesis or inherent design e.g. a long *lecture* style tutorial
- Lack of access to a credible teacher/ facilitator who can provide assistance with challenging concepts.
- The target learner does not have the technical ability or inclination to access the learning object
- The target learner does not have access to the requisite hardware or software
- The target learner may have negative experiences of such learning objects or other pre-conceived negative attitudes that prevent them from participating in the learning experience

Despite these pitfalls, there have been numerous attempts to introduce learning objects into various educational curricula over the last twenty to thirty years. How

many of these initiatives have modelled themselves on the principles of Andragogy and embraced established principles of multimedia Instructional Design can only be guessed at.

Introducing Instructional Design(ID)

The field of instructional design and technology encompasses the analysis of learning and performance problems, and the design, development, implementation, evaluation and management of instructional and non-instructional processes and resources intended to improve learning and performance in a variety of settings, particularly educational institutions and the workplace. Professionals in the field of instructional design and technology often use systematic instructional design procedures and employ a variety of instructional media to accomplish their goals[41]

The Origins & History of ID

World War 2 & its aftermath

As the 20th century saw the revival of certain concepts that pertain to adult education, major world events were to herald the birth of Instructional Design as a discrete field of endeavour.

In World War 2 America the US Government was faced with a difficult situation. Thousands of skilled workers had been conscripted into the armed forces and this left

a severely depleted workforce with which to service industry. This was compounded by the need to rapidly provide manufactured goods for the war effort such as engines, weapons and general ordnance utilizing a workforce of hitherto unskilled civilians.

Those conscripted to the armed forces, similarly, were required to rapidly learn new skills.

The Government's response to this challenge was to create a series of training programs known as *Training Within Industry* or TWI. Each program was based on Charles Allen's[42] 4-point method of **Preparation, Presentation, Application, and Testing**. (Manufacturing) tasks were broken down into subtasks and each subtask was treated as a learning goal with repetition and refining of a subtask until it was performed perfectly. The end result was a perfectly executed task which was speedily reproducible. Most of the programs took the form of printed guides, audio guides or instructional films.

The end of the War placed the US in a strong financial position (and with very little overseas competition) and subsequently Government funding for TWI was withdrawn in 1945. It's legacy however can be seen in modern manufacturing techniques adopted by post-war Japan including the *Lean* and *Kaizen* philosophies which owe much to TWI.

Although based on his work of a decade earlier, 1949 saw the publication of Ralph Tyler's influential *Basic Principles of Curriculum and Instruction*[43]. This short publication was essentially a distillation of his previous work and focused on the

mechanics of successful curriculum delivery. Tyler stated that there were four basic requisites:

1.Defining appropriate learning objectives

2. Establishing useful learning experiences

3. Organizing learning experiences to have a maximum cumulative effect

4. Evaluating the curriculum and revising those aspects that did not prove to be effective[44]

In effect, this set of guidelines transformed the teacher into a scientist who imposed a set of conditions upon the learning environment and then evaluated the response. These responses were used to effect changes that were more likely to be associated with the desired learning outcome.

1946 saw the emergence of educationalist Edgar Dale's Cone of Experience. The cone is demonstrated below:

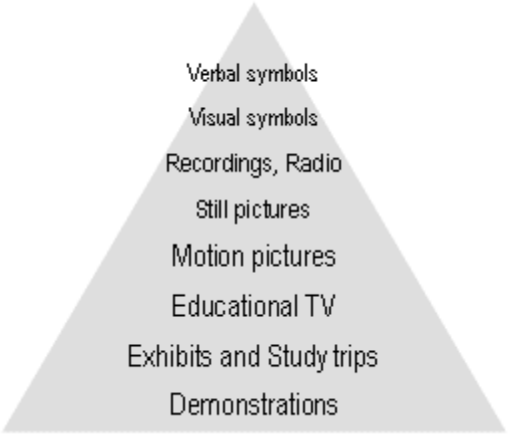

Fig 1.1- Dale's cone of Experience[45]

The cone demonstrates the level of abstraction required for different forms of instruction. This in turn allows the teacher to construct the lesson appropriately. Generally, the greater the level of abstraction (higher up the cone), the lower the likelihood of effective retention in long term memory. Although other representations of the cone have had percentages of retention erroneously attached to them, the Cone concept had a major impact on contemporary thinking about the relative value of different instructional media.

The 1950s- Behaviourism and the Programmed Instruction Movement

The 1950s was the decade when celebrated Behaviourist BF Skinner rose to his current place in the educational firmament. True to his behavioural roots, Skinner imported his concepts of Stimulus-Response (S-R) from the lab to the classroom when he published *The Science of Learning and the Art of Teaching* in 1954[46].

Skinner stated that "Programmed Instructional Materials" should be designed in such a way that they are presented as small and discrete tasks (thus individually being easier to complete) with the emphasis being on *immediate* positive reinforcement upon completion. Emphasis was also placed on self-paced learning. This approach is regarded by many as the archetypal Instructional Design method because it espoused an empirical approach to instruction with frequent reassessment of which Programmed Instructional Materials worked and which didn't (**Formative Evaluation**).

Skinner's work also served to reinforce Tyler's earlier emphasis on objectives.

Objectives were at the heart of a seminal 1956 publication by Benjamin Bloom titled *Taxonomy of Educational Objectives.* Bloom's research group essentially distilled objectives into three desired domains:

- **Cognitive**: mental skills (*Knowledge*)
- **Affective**: growth in feelings or emotional areas (*Attitude*)
- **Psychomotor**: manual or physical skills (*Skills*)[47]

Objective setting was also a central plank in Robert Mager's highly influential *Preparing Objectives for Programmed Instruction* first published in 1962 which not only described desired learner behaviours and the conditions under which certain instructional objectives could be achieved but also placed significant emphasis on the concept of using criteria against which the performance could be judged[48].

The 1960s- The Space Race, Events of Learning and Learning Hierarchy

1957 saw a landmark event in the USSR's successful launch of the first ever satellite, Sputnik.

Conscious of the fact that they were falling behind technologically, the US Government passed *The National Defense Education Act* (NDEA) in 1958. The act allowed for extra funds to be made available for in improvements in the learning of science and technology at all levels. The specific provisions of the act stated it would

fund : *"laboratory and other special equipment, including audio-visual materials and equipment and printed materials (other than textbooks), suitable for use in providing education in science, mathematics, or modern foreign languages"*[49]

Instructional materials for this purpose were initially in the traditional form but Scriven, amongst others, pointed out that this instruction was not particularly effective and suggested that it would be more effective if learning materials were tried out with learners and then improved before they were finalised. Scriven termed this *formative* evaluation which he compared with *summative* evaluation where the learning resource was evaluated in its final form[50].

In 1965 Robert Gagne first published *The Conditions Of Learning*[51] in which he describes five different types (or domains) of learning outcomes:

- Verbal information
- Intellectual skills
- Cognitive strategies
- Motor skills
- Attitudes

Different internal and external conditions must be in place to facilitate these outcomes. For example, a change in attitude may require a particularly persuasive argument or exposure to a relevant role model.

Much of this was an expansion of earlier research on instruction that he conducted for the US military[52].

Gagne argued that although the conditions for each outcome needed to be different, there was commonality in the *processes* by which learning in all these domains could be achieved. These he termed his nine *instructional events*:

1. Gaining attention (reception)
2. Informing learners of the objective (expectancy)
3. Stimulating recall of prior learning (retrieval)
4. Presenting the stimulus (selective perception)
5. Providing learning guidance (semantic encoding)
6. Eliciting performance (responding)
7. Providing feedback (reinforcement)
8. Assessing performance (retrieval)
9. Enhancing retention and transfer (generalization)

Gagne illustrated this concept with a well known example:

1. Gain attention - show variety of computer generated triangles
2. Identify objective - pose question: "What is an equilateral triangle?"
3. Recall prior learning - review definitions of triangles
4. Present stimulus - give definition of equilateral triangle
5. Guide learning- show example of how to create equilateral
6. Elicit performance - ask students to create 5 different examples
7. Provide feedback - check all examples as correct/incorrect
8. Assess performance- provide scores and remediation

9. Enhance retention/transfer - show pictures of objects and ask students to identify equilaterals

In this, and later work, Gagne finally postulated that there existed a hierarchy within the intellectual skills domain where mastery of the more basic elements was needed to allow mastery of "higher order elements".

For example:

1. State or write the formula for the relationship between the radius of a circle and it's circumference
2. Explain what the formula means (needs step 1)
3. Use the formula correctly when instructed (needs step 2)
4. Understand when to use it, without instruction (needs step 3)
5. Know how to interpret the results (needs step 4)

As we can see each successive step requires mastery of the preceding one.

The 1970s- genesis of the ADDIE model

The seventies saw a rise in the uptake if Instructional Design with a number of countries such as Korea and Indonesia adopting ID models to resolve instructional problems[53]. Major companies began using ID as a means of addressing their training and instruction difficulties[54] while the educational establishment saw the inception of a number of postgraduate courses in Instructional Design[55].

The major advance in use of ID came, again, from the Armed Forces. The US Army came to realise that the gulf between the technological complexity of modern warfare and the abilities of it's personnel was growing. This provided the stimulus for the formal adoption of an ID programme developed by the University of Florida which comprises *a comprehensive five phase process encompassing the entire training/educational environment.* This is the first known description of the **ADDIE**[56] model although at the time it was more commonly known as SAT (System Approach to Training) or ISD (Instructional System Design).

ADDIE stands for **Analyse, Design, Develop, Implement and Evaluate**. The process can be pictorially represented thus:

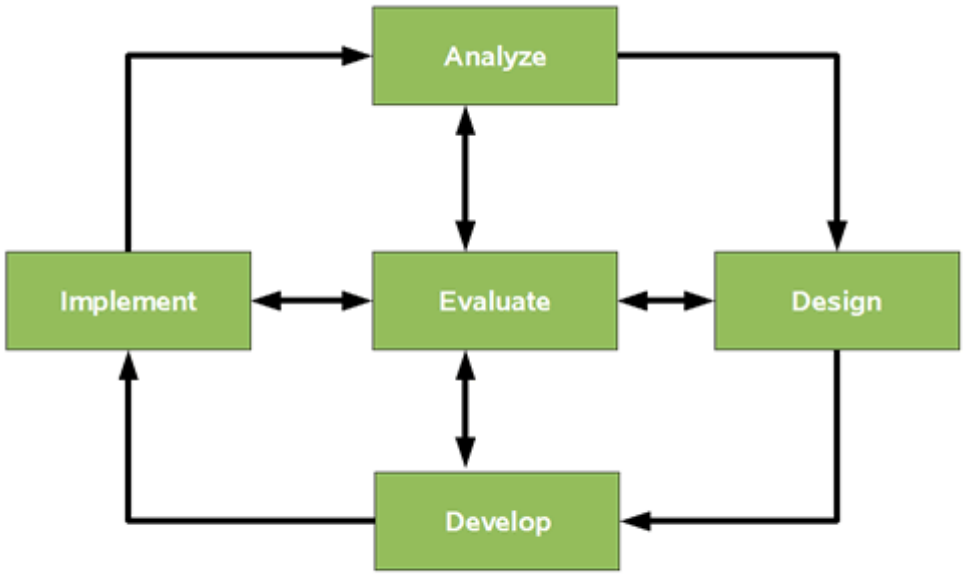

Fig 1.2- Pictorial representation of the ADDIE model[57]

Analysis

During analysis, the designer typically identifies:

- the learning problem
- the goals and objectives
- the learner's needs
- existing knowledge, and any other relevant characteristics
- the learning environment
- potential constraints
- the delivery options
- a timeline for the project

Arguably, analysis is the most important part of the process.

Design

During the design phase, the following questions may be asked:

- How should content be organized?
- How should ideas be presented to learners?
- What delivery format should be used?
- What types of activities and exercises will best help learners?
- How should the course measure learners' accomplishments?

Development

In the development phase, one creates and assembles the materials and media in line with the decisions made during the design phase. During this phase, the project is reviewed and revised according to the feedback or suggestions. The key steps are:

- Create a prototype

- Develop the materials
- Conduct a review of the project
- Run a pilot session

Implementation

The implementation phase has two major components:

- Marketing of materials for adoption by the learner (or teacher)
- Provide help or support as needed

Evaluation

This is the final stage of the ADDIE model which determines whether or not the proposed solution to the problem has succeeded. As can be seen from Fig 1.2, the process can be formative i.e. evaluation informs each of the preceding phases. The evaluative process is more commonly thought of as being summative i.e. deciding whether or not the venture has been worthwhile. It should, more correctly, be thought of as consisting of both summative and formative components.

Rapid Prototyping

Within the early stages of ADDIE there exists the opportunity to develop an inexpensive early model to try out on the target audience. This is known as Rapid Prototyping[58]. This allows early feedback and the facility to make changes before the developer has gone too far down the development route. Such a strategy reduces the likelihood that the final product is "off target" i.e. not meeting instructional goals.

Rapid Prototyping is most applicable to situations where the product is low cost and can be easily created at an early stage.

Other ID Models

Scores of other models arose subsequently, all attempting to describe a simplified process of instructional design. Some were situational and only described schemas that were applicable to specialised environments. Others were more generalized. An example is the Dick and Carey model of 1996 as shown below:

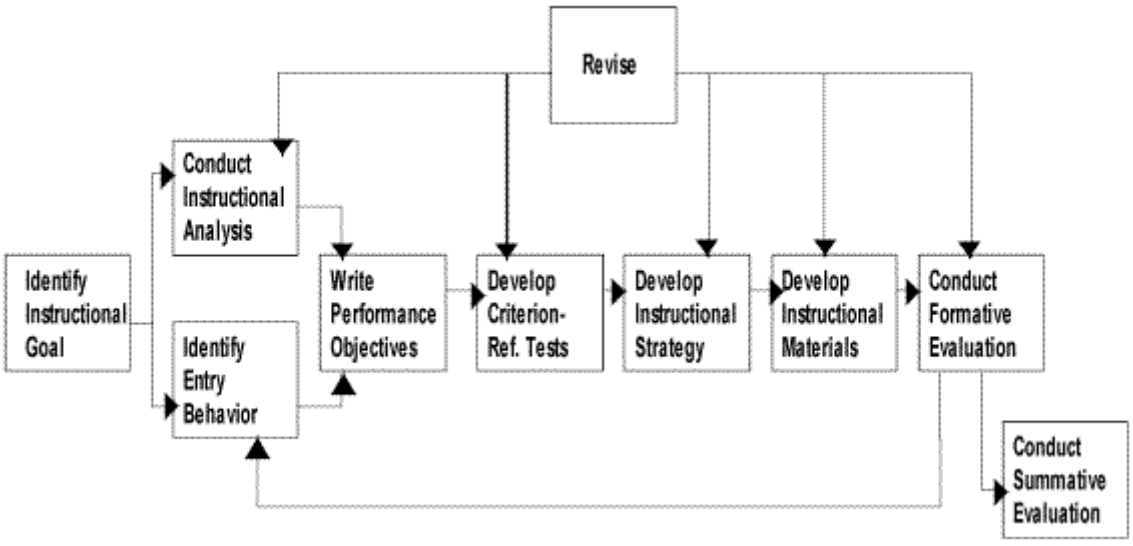

Fig 1.3. The Dick & Carey model[59]

On the surface, the Dick & Carey model is radically different from ADDIE but closer inspection reveals the same basic components.

It is this commonality of features that has led to the ADDIE model being widely adopted within the ID community.

The 1980s- Rise of the Microcomputer

The 1980s witnessed a sharp rise in the use of affordable microcomputers in all areas of human endeavour. ID practitioners were not slow to recognise the potential of computers.

Seymour Papert in 1984 stated that the computer would be "the catalyst of very deep and radical change in the educational system". He went on to state that every child would have access to a microcomputer by 1990 although subsequent surveys found this estimate to be some way short of the mark.[60] Moreover, educators reported that most computers were being used to learn basic word-processing skills or computer programming.

The 1990s- Internet & Multimedia

As the 90s progressed, personal computers became ever more sophisticated and allowed the user to view pictures and sound files. This coincided with the advent of the internet. The effect on ID was marked.

Since 1995 there has been a sharp increase in the use of the internet to deliver distance learning[61]. Bassi and Van Buren enthusiastically stated:

"In 1997, about half of all organizations in the sample delivered training via CD-ROMs, and roughly a third delivered training via electronic mail and local area

networks. By the year 2000, 80 percent expect to be using CD-ROMs; intranets (70 percent) and the Internet (58 percent) ranked second and third. In fact, both forms of Web-based training are projected to triple in use between 1997 and 2000"

Others sounded a more cautionary note suggesting that the rise in internet learning must go in parallel with the acceptance that the newer technologies should do more than just replicate classroom teaching methods online[62]. This is the basis of the following section on Multimedia Learning Theory.

Multimedia Theory and Learning

"In a few years, multimedia computers will be an anachronism. All computers will readily integrate images, sounds, and motion video - and this capability will be built onto the motherboard as an essential part of what a computer is. Already, these computers are connected to the Internet for world-wide real-time sharing of high-quality images, sounds, and video.[63]"

"I believe that the motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks..."
64

Origins and early examples

Although the term multimedia is most commonly (and correctly) taken to relate to personal computers, it's origins as a concept date back to prehistory. Any point at which a drawing has accompanied written text or a person has physically

demonstrated an action whilst describing it can be described as a multimedia experience for the viewer.

Simply put, multimedia is the conveying of information using words and pictures.

Computers are not the only devices that can claim to be multimedia artefacts; a book or any other print medium that contains words and pictures can claim to be "multimedia". In fact computers (and specifically the World Wide Web) are the latest in a series of innovations that have laid claim to the title of "revolutionary learning aid".

If we consider that the widespread uptake of radio in the thirties led some notable commentators to speculate that there would be "*a radio in every classroom*" we can see that such enthusiasm became a casualty of history. Similar claims were made for television in the fifties but again the reality was underwhelming[65].

Early computers were also not immune to human hyperbole and although large scale US government funded projects such as PLATO and TICCIT made a significant contribution to our understanding of the role of computers in learning, they were ultimately viewed as failures due to under-utilisation by faculty members[66]. TICCIT was switched off before the nineties.

Perhaps what links the above examples is that neither of them was developed by an educator and at no point was appropriate learning theory applied in their adaptation

for educational purposes. The development of the technology came first and the educational application was something of an afterthought.

A cognitive theory of multimedia learning

In 1986 Allan Paivio consolidated his earlier work on imagery and associative learning and proposed a *dual-coding* theory of information processing.[67]

Dual Coding Theory proposes that memory consists of two separate but interrelated channels for processing information: verbal and visual. The verbal and visual systems can be activated independently, but there are interconnections between the two systems that allow dual coding of information. The interconnectedness of the two systems permits communication and flow of stimuli from one system to the other, which in turn facilitates the interpretation of our environment. It can be represented pictorially below (Fig.1.4)[68]

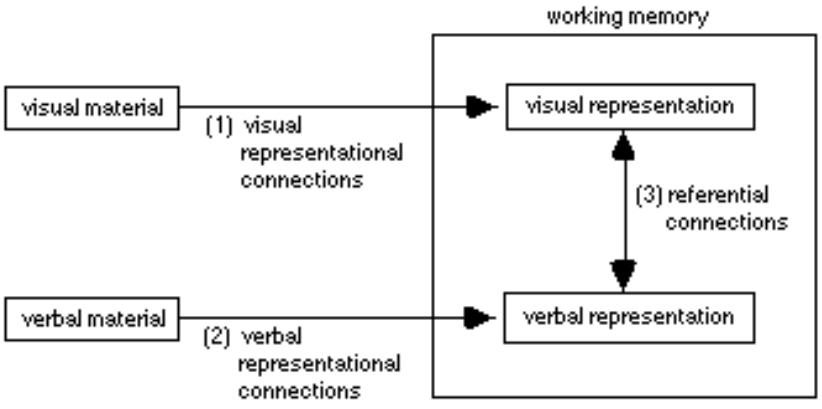

Fig. 1.4- Dual coding theory

The referential connections in working memory have a special significance for the learning process. For example a visual image will be reinforced by an audio commentary which is complementary to it and so the likelihood of retention is higher.

Dual coding theory and other concepts in cognitive learning theory such as working memory[69] vs. long term memory were drawn together by noted psychologist Richard Mayer to form a coherent theory of cognitive multimedia learning. This is pictorially represented in Fig.1.5:[70]

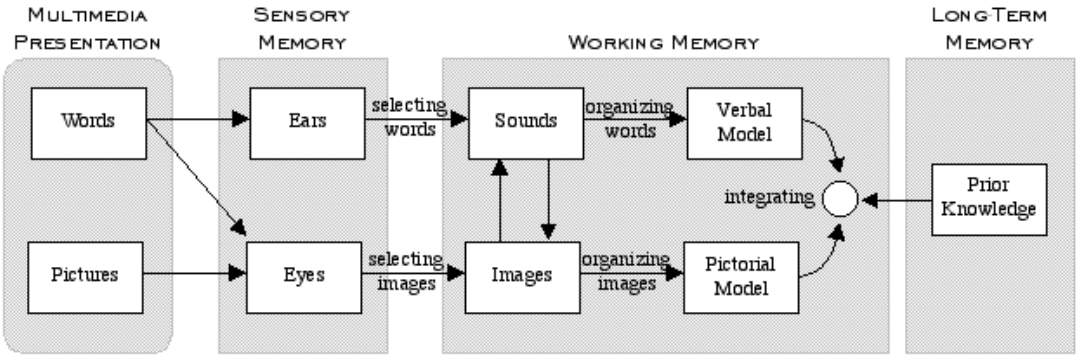

Fig.1.5- A model illustrating multimedia learning theory

This model is based upon three primary assumptions:

- Visual and auditory experiences are processed through separate and distinct information processing channels.

- Each information processing channel is limited in its ability to process experience/information at one time.

- Processing experience/information in channels is an active cognitive process designed to construct coherent mental representations[71].

The process of information assimilation arising from this model is as follows:

- Selection of relevant words for processing in *working verbal memory.*
- Selection of relevant visual images for processing in *working visual memory.*
- Organising the words into a *verbal mental model.*
- Organising the images into a *visual mental model.*
- Integration of visual and verbal mental models with each other with input from *prior knowledge.*

Principles of Multimedia Design

From this and over a decade of experimental work, Mayer developed a series of seven multimedia principles (Table.1.2)[72]

Principle	**Application in Practice**
Multimedia Principle: Students learn better from words and pictures than from words alone.	On screen animation, slide shows, and narratives should involve either written or oral text and still or moving pictures. Simple blocks of text or auditory only links are less effective than when this text or narration is coupled with visual images.
Spatial Contiguity Principle: Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.	When presenting coupled text and images, the text should be close to or embedded within the images. Placing text under an image is sufficient, but placing the text within the image is more effective.
Temporal Contiguity Principle: Students learn better when corresponding words and pictures are presented simultaneously	When presenting coupled text and images, the text and images should be presented simultaneously. When animation and narration are both used,

rather than successively.	the animation and narration should coincide meaningfully.
Coherence Principle: Students learn better when extraneous words, pictures, and sounds are excluded rather than included.	Multimedia presentations should focus on clear and concise presentations. Presentations that add "bells and whistles" or extraneous information impede student learning.
Modality Principle: Students learn better from animation and narration than from animation and on-screen text.	Multimedia presentations involving both words and pictures should be created using auditory or spoken words, rather than written text to accompany the pictures.
Redundancy Principle: Student learn better from animation and narration than from animation, narration, and on-screen text.	Multimedia presentations involving both words and pictures should present text either in written form, or in auditory form, but not in both.
Individual Differences Principles: Design effects are stronger for low-knowledge learners than for high-knowledge learners and for high spatial learners rather than from low spatial learners.	The aforementioned strategies are most effective for novices and visual learners (e.g., high-spatial learners). Well structured multimedia presentations should be created for those they are most likely to help.

Table.1.2- Mayer's multimedia principles

In most cases the empirical data upon which these principles are based demonstrate improved information *retention* and *transfer* (except the temporal contiguity principle where retention was equal when visual and auditory items were played simultaneously and successively)[73].

Heuristic evaluation and the user interface

When considering the design of a multimedia learning object, a common pitfall is to integrate principles of good learning and contemporary theories of multimedia information processing and yet to subsequently neglect the user interface. This rather negates the exercise of developing a learner centred model. The quality of the user interface will allow the self directed learner to rapidly decide if the information is worth accessing and yet it is only fairly recently that work has been carried out in this area.

In the early nineties, usability consultant Jakob Nielsen developed the concept of heuristic evaluation. This is a usability evaluation method for computer program interfaces and how the program would best fit with the requirements of the learner/user. The need for such a methodology arose from the observation that extensive testing of every user interface was time consuming, occasionally unreliable and prohibitively expensive.[74]

Heuristic interface evaluation involves the testing of an interface using ten established rules which, if met, suggest that the user will have less difficulty navigating the program. These heuristics are general rules that appear to describe common properties of usable interfaces:

- **Visibility of system status** - The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
- **Match between system and the real world** - The system should speak the users' language, with words, phrases and concepts familiar to the user, rather

than technical jargon. Real-world conventions should be adhered to, making information appear in a natural and logical order.

- **User control and freedom** -Users often choose system functions by mistake and will need an easy exit strategy to leave the unwanted state without having to go through an extended dialogue.
- **Consistency and standards** -Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
- **Error prevention** -Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
- **Recognition rather than recall** - Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.
- **Flexibility and efficiency of use** –Accelerators, unseen by the novice user, may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
- **8. Aesthetic and minimalist design** -Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

- **9. Help users recognize, diagnose, and recover from errors** -Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.
- **10. Help and documentation** -Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large[75].

While Nielsen takes a prescriptive approach which has found its critics[76], it is generally agreed that his recommendations are applicable to most learning object interfaces.

The significance of learning styles

It has been long been established that learners have different styles of learning/personality and over the years researchers have made inroads towards applying classification systems to these styles. Perhaps the best known classification of personality is the Myers-Briggs classification. This system attempts to take the personality types proposed by Carl Jung and make them applicable to people's life situations. The types the Myers-Briggs index sorts for, known as dichotomies are *extraversion / introversion, sensing / intuition, thinking / feeling* and *judging / perceiving*. Participants are given one of 16 four-letter abbreviations, such as ESTJ or INFP, indicating what their preferences are.

Published work on users of learning objects suggests that users (in this case medical students) with certain traits are more likely to use multimedia learning objects than others e.g. students with a "sensing" preference tended to use both CAL applications more than the "intuitives"[77].

Similar differences in aptitude of uptake of learning objects have been found in user traits with different classification tools such as the *visualiser-verbaliser dimension*[78] and the *Gregorc style delineator*[79]. From a pragmatic point of view the significance of these findings is unclear and there is no consensus on how such differences might be put forward into a framework for creating learning objects. More recent research involving high quality randomised trials has cast doubt on the importance of cognitive learning styles and suggests that they may not greatly affect the examination performance or satisfaction levels of students exposed to web based learning resources[80].

Chapter 2- Existing Literature on the Use of Computer Aided Learning in Medical Schools

Introduction

"The clinical researcher rarely looks at multifactorial interventions but instead exposes patients to a tightly controlled set of interventions. This is not what happens with media-comparative research. Such research would require a uniform medium such as 'computer' which can be compared with some other uniform medium such as 'teacher.' Such uniformity does not exist."[81]

When reviewing the published literature on computer aided learning, what immediately becomes apparent is that the search for relevant papers is considerably more difficult than conducting a literature review for science-based topics.
By way of explanation an example is necessary:

If one wishes to know what is published on the subject of, for example, the use of plasmapheresis in the treatment of Crohn's disease then the search terms are limited i.e. *Crohn's, inflammatory bowel disease, plasmapheresis, apheresis,* and *treatment.*

Combinations of the above will yield most if not all of the published literature provided that the most relevant database, in this case Medline, is interrogated.
The nature of medical terminology facilitates the process.

By contrast, when searching for literature on particular subjects in the social sciences even as they pertain to medicine, it can prove to be a semantic minefield. This is mainly because there is no agreed common terminology.

The problem is well illustrated when dealing with the subject matter of this thesis, where a number of synonymous keywords are searched for e.g.:

- medical students, clinical students, healthcare professionals, medical undergraduates.
- computer aided instruction, computer aided learning, distance learning, e-learning, multimedia learning, blended learning, learning objects, educational technology.

An additional complication relates to the rapid evolution of hardware and software.

Twenty years ago, authoring and producing a multimedia CAL program required high levels of technical expertise, expensive hardware (e.g. Laserdiscs) and offered access to a limited number of students. The development of the CD-ROM and the Internet as well as easy authoring tools such as Powerpoint® and Dreamweaver® created an opportunity for teachers to enter the era of CAL where content could be produced with modest technical know-how and delivered relatively cheaply. In this rapidly changing landscape, which now offers students almost ubiquitous access to multimedia, how relevant is the older research, e.g. those that examined the efficacy of videodisc tutorials or pre-Windows programs?

A further challenge is choosing which databases to search. Research and review publications dealing with computer aided learning for medical students may well be published in biomedical databases such as PubMed or in psychologically oriented

sources such as PsycInfo or even those databases dedicated to general education such as ERIC.

Clearly the net must be cast wide and the search terms kept well circumscribed to obtain the relevant literature without becoming overloaded with data or conversely missing vital studies.

Purpose of review

The purpose of this review is to examine the current published literature on Computer Aided Learning as it pertains to Medical Students with a view to developing a computer aided learning program that conforms to the ideals laid out in the review and introductory chapter.

Literature Search Methodology

With the help of an experienced Librarian, the following databases were searched via the UCL library portal and Athens during April 2010:

- CINAHL[82]
- ERIC[83]
- PsycInfo[84]
- PubMed/ Medline[85]

In addition a hand search was performed of the major peer-reviewed journals in the field of Medical Education:

- Medical Education
- Academic Medicine

- Medical Teacher

Finally, the reference lists of large review papers were interrogated to look for relevant articles that may have been missed.

Search Terms, Inclusion and Exclusion Criteria

Search terms were varied and included Boolean combinations of the following:

- Medical Students
- Students
- Undergraduate
- Medical
- Clinical
- Computers
- Computer Aided Learning
- Computer Aided Instruction
- Computer Assisted Instruction
- Online
- Web-based
- Electronic
- Learning object
- Virtual Learning Environment
- Self-instruct
- Teach
- Learn
- Blended Learning

- e-Learning
- Delivery
- Implementation

Inclusion criteria comprised:

- Peer reviewed articles
- Commentaries and general reviews of CAL in the context of medical students
- Published literature searches
- Trials comparing CAL with other learning strategies
- Surveys or questionnaires pertaining to CAL use by medical students
- Descriptive studies and evaluations of CAL initiatives
- Studies examining learner type/preferences in the context of medical students and CAL
- Articles which describe the implementation/delivery of CAL initiatives to medical students

Exclusion criteria comprised:

- Articles not originally authored in English
- Studies involving solely postgraduate medical education
- Studies pertaining only to students other than those studying medicine (i.e. Professions Allied to Medicine)
- Non-original research
- Articles prior to 1998- This cut-off represents the period when personal computers and specifically the internet started to become a widely available[86]

technology through the packaging of Internet Explorer® with Microsoft Windows®[87].

Results

A combination of database searches using the chosen terms and Boolean combinations, hand searches of journals and scanning of reference lists yielded a total of 235 publications which met the inclusion criteria from a total of 2500 citations. The trial flow overleaf (Fig 2.1) summarises the selection process:

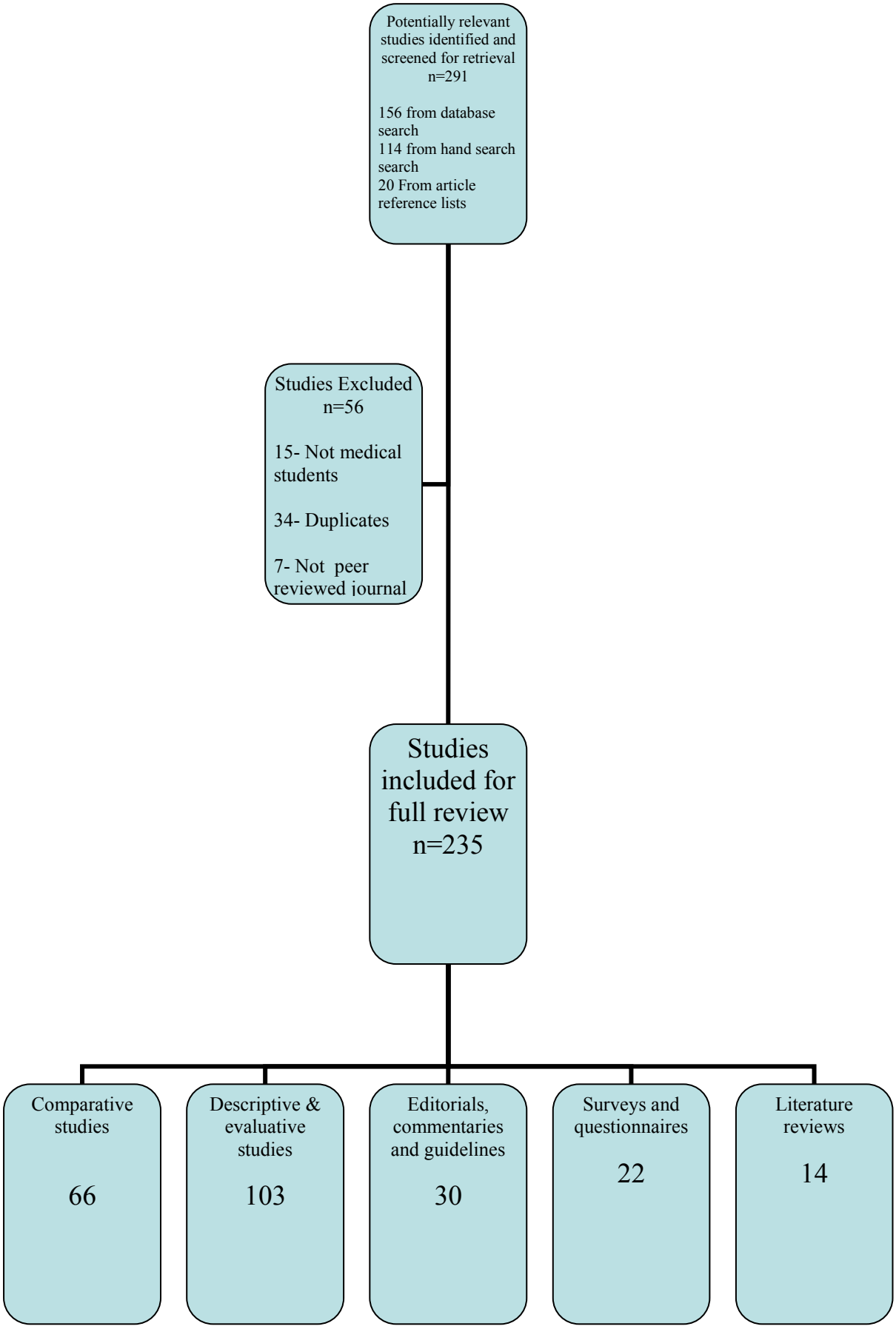

Fig 2.1- Trial Flow for literature review

Type of Article	Number of results meeting criteria
Editorials, commentaries and guidelines regarding CAL in the context of medical students	**30**
Published literature searches/reviews	**14**
Comparative studies- Trials comparing CAL with other learning strategies or CAL with CAL	**66**
Surveys or questionnaires regarding CAL use by medical students	**22**
Descriptive studies and evaluations of CAL initiatives	**103**

Table 2.1- Types of article yielded by search

Commentaries and general reviews of CAL in the context of medical students

The findings in this category are summarised in Table 2.2 below:

Author	Subject/Aspect of CAL	Broad conclusions
Wood & Vogel 2002[88]	Student attitudes to CAL	No significant benefit of CAL over traditional teaching , students suspicious of CAL initiatives supplanting teaching
McKimm & Jollie 2003[89]	ABC of Web Based Learning	Tips on how to implement Web Based Learning. Significant potential to improve learning but warns against inappropriate use when other methods more effective.
Dacre & Haq 2003[90]	CAL resources available in rheumatology	Wide variety of resources in different formats available in rheumatology. Concern over access to hardware and appropriate training
Candler & Andrews 1999[91]	Common Architecture in CAL Applications	Identifies cost effectiveness and inter-institution value of standardisation of CAL packages across platforms
Ward 2001[92]	General overview of CAL	Good availability of hardware but overwhelming amount of information of varying quality. Establishes hierarchy of quality in CAL

Cook 2005[93]	Critique of standard of research into CAL	Argues that majority of media comparative research is futile. Suggests more research into CAL-CAL comparisons and assessment of implementation
Masters & Ellaway 2008[94]	Introduction to CAL technologies	Emphasises economic and pedagogic advantages of CAL and posits that CAL is now embedded in most medical curricula
Harden 2008[95]	Future of CAL	Emphasises need for evolutionary not revolutionary change and discusses political and pedagogic reasons for this.
Ruiz 2006[96]	Impact of CAL on Medical Education	Cites beneficial impact of CAL but stresses key nature of teachers as facilitators
Dubois & Franson 2009[97]	Integrating basic science CAL into the medical curriculum	Adopts ID based schema as a guide to successful implementation
Ruiz & Mintzer 2006[98]	Description of Learning Objects	Identifies characteristics of Learning Objects including reusability, accessibility and interactivity
Thakore & McMahon 2006[99]	Quality of current CAL initiatives	Emphasises need for training of teachers in CAL. Warns against simply placing current text resources online. Advises taking a more learner-centred approach
Meryn 1998[100]	Review of "emerging" communication technologies	Describes the internet as a "minefield of opportunities" & expresses concern over the potential for misinformation
Sandars & Haythornthwaite 2007[101]	Introduction to Web 2.0	Places CAL within the "ecosystem" of medical education. Discusses the increase in personalization of learning and active participation by learners
Choules 2007[102]	State of the art in CAL provision	Expounds on CAL Reusable Learning Objects (RLO) as the gold standard. identifies need for CAL to fill a gap but also to work as part of a Blended Learning programme
Maybury & Farah 2009[103]	Utility of CAL for microscopy teaching	Uses Virtual Microscopy as an exemplar or the transition from teacher- centred to student-centred learning
Cook 2009[104]	Impact of CAL research on educational practice	Little impact on educational practice due to persistence of unhelpful media-comparative research. Advocates more basic research and "field testing"
Koller 2000[105]	Developing CAL in a community based hospital	Practical guide to introducing CAL in this setting using ID principles with emphasis on project management and adequate planning
Sandars 2009[106]	Podcasting in Medical	Explanation of value/ubiquity of

	Education	Podcasting and need for maintaining quality whilst maximising dissemination. Need to evaluate what does/doesn't work
Hagdrup 1999[107]	IT provision for students in community General Practice	Describes current access to CAL hardware in teaching GP practices and contrasts with greater access within hospitals. Identifies need to provide more resources in the community to match rising student numbers
Winding 1998 (for World Federation for Medical Education)[108]	WFME guidelines on using computers in Medical Education	Advises greater CAL integration into curricula, greater information sharing and increased recognition for teachers utilising CAL
Dudcut & Fontelo 2008[109]	Mobile Devices in health education	Need for learning on the move for healthcare students mandates an expansion in the use of mobile devices
Hare 2007[110]	Case based online learning in psychiatry	Examines evidence for CAL in psychiatry teaching. Concludes that it is popular with students and valuable in a blended learning programme once the initial time and financial costs are overcome
Valcke & De Wever 2006[111]	Overview of CAL evidence base	"Meso level"- CAL positively impacts the efficiency of learning arrangements. "Micro" level- CAL is of use for presentation, organization, and integration of information
Vozenilek 2004[112]	Consensus statements on CAL utility in the Emergency Department	Identifies CAL as a means to safely gain experience and confidence prior to patient exposure
Mangrulkar 2002[113]	Telemedicine for Medical Education	Telemedicine based CAL is underutilised by the medical community despite great potential
Vogel & Bennett 2001[114]	Production of a multimedia CAL CD-ROM	Outlines how a successful CAL CD-ROM can be produced in-house
Eva 2000[115]	Quality of CAL	Examines methods to import successful teaching practices into CAL
McAuley 1998[116]	Medical Student computer ownership	Discusses medical school requirements for computer ownership. Major institutional commitment to computer provision required for successful CAL integration
Berman 2007[117]	Roadmap to implementing CAL	Identifies need for a plan or roadmap. Identifies potential barriers to successful implementation

Table 2.2, Commentaries and general reviews of CAL

The scene is set by Wood and Vogel[118] who, writing in 2002, express cautionary note and suggest that:

- Medical students may be suspicious of any initiatives that further erode precious contact between students and teachers. As such, CAL faces a "public relations challenge" and should be seen as complimentary to existing teaching rather than replacing it. CAL may still free up valuable time for tutor led discussion
- There is still a strong affinity for paper based documentation as it can be annotated and is easily portable
- There is a lack of clear evidence that CAL is superior to traditional techniques although there may be an economic argument for its implementation
- A significant minority of students do not have access to an appropriately specified computer (this was at the time of writing in 2002)

This last point about having an appropriately specified computer is very much an echo of sentiments expressed by McAuley in 1998[119] who also asked a few key questions when computers were only just beginning to become widely accessible in medical schools:

- What kind of computer best suit the students' needs?
- Who needs computers?
- What might impede the process of teaching with computers?

McAuley concluded that computer access will need to be universal in future and that institutions will need to have mechanisms in place to ensure this.

Hagdrup[120] writing in 1999 was of the same opinion when it came to student access to computers within the general practice setting, contrasting rather limited computer provision in primary care when compared to secondary care and academic institutions.

Dacre and Haq[121] writing in 2003 reflect upon the wide variety of learning resources available to rheumatology students including Virtual Learning Environments (VLEs) and online teaching algorithms. They also stress the need for universality of access to computer hardware and access to training if CAL initiatives are to succeed.

In a wide ranging and detailed review, Ward et al[122] explore a variety of aspects of CAL in the context of medical education:

- They recognise that most medical schools provide their students with access to appropriately specified computers and that computers are increasingly becoming part of the teaching and learning environment
- There is an overwhelming amount of information available on the Web and teachers and students need help in selecting the best resources
- They describe the emergence of the "virtual campus" as an environment provided by the student's alma mater which provides all necessary course materials and resources to a large number of students at reduced cost.
- Mention is made of the 3 levels of web teaching:

"*Level one is similar to lecture notes: material that can be placed on the web as it is. Level two requires interactivity, linking multiple-choice tests with feedback or faculty assessments. Level three requires custom programming, such as animations or simulations*"[123]

- Emphasis is placed on the importance of training teaching staff in the methodology for rigorously evaluating CAL based interventions in the face of rapid technological development

Ruiz[124] is also keen to endorse the potential of CAL in a number of educational arenas and highlights many of the aforementioned benefits but warns against the teacher simply becoming a "distributor" of resources. Emphasis is placed on the teachers shaping themselves into facilitators who select appropriate material in terms of content and format as well as playing a pivotal role in competency assessment.

The need for effective CAL training for teachers is echoed by Thakore and McMahon[125] who consider it central to the effective to the provision of teaching and information via the new media. They comment that while VLEs (Virtual Learning Environments) are widely available, many faculties choose to ignore the potential of the technology and simply use the VLEs as a repository for digitised versions of existing lectures. Improved examination results related to the introduction of CAL is alluded to in the context of "blended learning" which refers to careful mixing of CAL with the existing curriculum. Initiatives that are more likely to succeed in this aim are those that present a more learner-centred approach than others (Table 2.3):

Teacher Centred	**Student Centred**
Lecture handouts placed on website	Structured and monitored post-lecture Discussion group
Photographs etc. presented as static examples	Learning objects provided which allow students to match images to textual descriptions and give instant feedback
List of useful websites provided	Students asked to review websites individually and to report findings to discussion groups

Table 2.3[126]- Teacher centred vs. Learner centred

Thakore and MacMahon suggest that the clinical encounter should be used as a cornerstone when designing CAL programs and that interactivity should be built in as an integral function.

Choules provides an overview of the current state of the art in CAL provision for the assimilation of *Knowledge, Skills and Attitudes*[127]. The assertion is that there is a "Holy Grail" for creators of CAL which is *"the ability to use and reuse the RLO (reusable learning object). This might be a video or perhaps a piece of text that could be used in a number of settings: case scenario, skills teaching, virtual tutorial, examination, multimedia adjunct to a real tutorial."*

Advice is given on how to set up an e-learning website and the concept of "just in time" learning is introduced e.g. rapid acquisition of information from the internet when it is required to solve a current clinical problem. Consideration is also given to how CAL might help in the provision of training for working doctors, many of whom cannot be in the same place at one time for formal teaching due to the constraints of the European Working Time Directive (EWTD).

There is also mention of the value of CAL in patient simulation but the caveat is added that this is limited and does not replace the expert bedside tuition that is required in a real clinical setting.

Choules' conjecture is that CAL is no panacea but neither is it likely to be a passing fad. Rather CAL should be considered an invaluable addition to the "toolbox of learning".

Berman et al[128] write of the need to have an effective "roadmap" for the provision of CAL as an essential means of improving clinical education in the face of the ever expanding amount of knowledge that medical trainees are expected to assimilate. They opine that a roadmap is necessary as there are a number of barriers to the successful implementation of CAL and they assert that a roadmap will provide tools to overcome these barriers as they are encountered.

The barriers they identify are:

- **Lack of evidence for effectiveness of CAL**- most studies assessing CAL make direct comparisons with more traditional methods of teaching. As the opening quote to this chapter suggests, these comparisons cannot easily be made and many of these studies are subsequently both philosophically and methodologically questionable. Many such studies labour under the illusion that CAL is in some way designed to directly *replace* another, more traditional, form of instruction. Nevertheless, most studies conclude that CAL is as effective as traditional methods and usually not more so.
- **The disconnect between developers, educators and students**- Both educators and, if employed, developers may conclude that one form of CAL is effective and subsequently impose it upon students without taking into account the learning habits and preferences of their target audience. Due consideration needs to be given to the perceived acceptability of the initiative

to the students as well as the place CAL may have in an already overloaded curriculum.

- **Ineffective integration by course directors**- There is little evidence to suggest that simply making CAL available leads to effective *integration* within a curriculum and so *implementation* is not possible. Integration requires acceptance and active participation from course directors and an expectation needs to be placed on the students that assimilation of the content of the CAL module is required.
- **Funding**- When an acceptable CAL module is developed, it frequently fails because there is little or no ongoing funding to support it through the phases of integration and implementation. The solution is for higher education institutions to have fiscal mechanisms in place that will provide financial support for viable schemes through all the 3 phases of development, integration and implementation.

As discussed in Chapter 1, the principles of Instructional Design (ID) are well established and are now widely used when developing instructional materials both online and otherwise. With this in mind it is interesting to note that out of thirty commentaries and guidelines, there are only two articles (Koller[129], Dubois & Franson[130]) which explicitly mention ID as a schema for designing CAL applications.

This does raise the possibility that either medical educators have not sufficiently studied the craft of the courseware designer or have at least taken key ingredients of the ADDIE model without making explicit its origins.

Another interesting trend observed when looking at the above reviews in chronological order of publication is the tendency for earlier commentators to cite the significant potential of CAL to improve teaching but the need for increased access and good quality studies to assess effectiveness. Later publications appear to accept that access to suitably specified hardware is almost universal (possibly due to the falling relative costs of such equipment) but also that research that has taken place in the interim has largely failed to inform the debate.

Possibly the most vociferous critic of contemporary CAL research is David Cook[131] who wrote in 2005 and again in 2009 about "*the research we should be doing*". Cook uses the analogy of the early automobile versus the horse-drawn carriage as a way to illustrate the absurdity of media-comparative research. Both have advantages and drawbacks but both have their niches and one cannot entirely supplant the other. Thus it is with classroom/bedside teaching versus CAL. Instead, he strongly advocates research into when to use CAL and how best to implement CAL.

Published Literature Searches

A total of fourteen literature reviews were included for analysis- they are tabulated below:

Authors	Subject	Type of Review	No of articles/ citations retrieved	Conclusions/Analysis
Adler 2000[132]	Changes in types of research articles pertaining to CAL over time	Mapping review	1071	Increase in publications numbers with time but no change in type of publication. Few authors with multiple citations and majority in small volume journals. Mostly descriptive studies
Lau & Bates 2004[133]	Synchronous distance learning & video conferencing for undergraduates	Mapping review	50	Paucity of studies regarding synchronous learning with published data having heavy emphasis on personalised, asynchronous learning
Letterie 2003[134]	Quality of studies evaluating CAL with emphasis on obstetrics and gynaecology	Critical review	210 (13 articles in O&G)	Enthusiastic endorsement of CAL by cited authors & their subjects but few good quality studies demonstrating superior outcome compared to traditional teaching
Childs 2005[135] for the HeXL project	Barriers to and solutions/critical success factors for e-learning in the health field	Systematic review	57	Barriers are: Requirement for change; costs; poorly designed packages; inadequate technology; lack of skills; need for a component of face-to-face teaching; time intensive nature of e-learning; computer anxiety. Solutions are: Standardization; funding; integration of e-learning into the curriculum; blended teaching; user friendly packages; access to technology; skills training; support;
Wofford 2001[136]	RCTs comparing CAL with lectures	Critical review	8	Slight bias in favour of CAL. CAL offers future potential in blended learning environment
Greenhalgh 2006[137]	RCTs comparing CAL with traditional teaching	Critical review	12	Overall modest or no significant benefit with CAL. Significant methodological weaknesses in most studies
Chumley-Jones 2002[138]	Synthesis & evaluation of literature on Web Based Learning (WBL)	Systematic review	76	WBL equivalent but not superior to traditional teaching. WBL complementary. Concern over hidden costs and lack of Instructional Design principles
Ruiz & Cook 2009[139]	Identify evidence based principles for use of animations in CAL	Critical review	Not specified	Very little evidence base for animations. Not all animations useful. Need to consider cognitive load & multimedia design principles
Hardin & Patrick	Evaluation of content &	Overview	62	Review methods address the themes of practical aspects, content and

1998[140]	terminology of published CAL developer reviews			empirical data. No clear structure to reviews. Reviews conducted by developers or teachers rather than students
Cook 2008[141]	Evidence for effectiveness of web based learning (WBL)versus no intervention or non-internet interventions	Meta-Analysis	201	WBL superior to no intervention. Equal efficacy compared to non-internet interventions. Need to focus on avoiding media comparative research
Cook 2010[142]	Synthesis of how to improve web based learning (WBL)	Systematic review & Meta-Analysis	51 (30 RCTs)	Interactivity, practice exercises and feedback associated with better learning outcomes
Tam 2009[143]	Evaluate CAL for teaching anatomy	Critical review	8	CAL not a replacement for traditional anatomy teaching. More research needed on integration of CAL. Studies of poor quality
Gaffan 2006[144]	Evaluate methods of educating undergraduates about oncology	Systematic review of CAL & other methods	48	CAL is only "acceptable" and not a replacement for traditional teaching
Wong 2010[145]	What aspects of CAL work and under what circumstances	Qualitative systematic review	249	Learners very variable but CAL needs to align technical attributes to learner's needs & to provide interaction

Table 2.4. Published literature reviews

In 2000, Adler and Johnson published a literature search of Medline and ERIC which looked at CAL articles in terms of trends in article type, publication date and calibre of journal[146]. 60% reported demonstrations of CAL programs, 16% described media comparative trials and 11% were commentaries and analyses. With time, the number of publications increased significantly but the breakdown remained the same. Interestingly, fewer than 10% of articles appeared in core medical journals and most of the authors had less than 3 citations in the field of CAL.

Lau and Bates took a different approach and conducted a literature review with an emphasis on synchronous distance learning[147]. They reviewed 50 publications which reported various descriptions of CAL initiatives within different settings as well as

review articles suggesting guidelines for providers contemplating e-learning initiatives. In common with other investigators, they found a paucity of well designed trials with generalisable conclusions. In addition, they found no publications that dealt with the synchronous delivery of teaching across different campuses or environments.

Somewhat older publications were examined by Gerard Letterie[148] who, in 2003, looked at all articles published between 1988 and 2000 with special emphasis on obstetrics and gynaecology. The range and scope of publications mirrored the findings of the Adler and Johnson study. The conclusions were much the same as Lau and Bates inasmuch as the apparent advantages reported in many of the studies were not usually backed up by sound trial methodology. An interesting departure was the description of a study which evaluated the setup and ongoing costs of an anaesthesia CAL initiative which suggested that CAL represented a significant ongoing expense which needed to be justified.[149]

Much in the spirit of Berman's "roadmap", a study was commissioned by the University of Northumberland in 2003[150] to look at the barriers to implementation of CAL in the NHS and to suggest some possible solutions. Information gathered from a systematic literature search was bolstered by telephone interviews and survey questionnaires.

The main barriers identified were:

- resistance to change
- costs

- poorly designed packages
- inadequate technology
- lack of computer skills
- need for a component of face-to-face teaching
- time intensive nature of e-learning
- computer anxiety

Suggested solutions to these obstacles included standardization strategies, secure funding, integration of e-learning into the curriculum, blended teaching, user friendly packages, access to technology, skills training, support, employers paying e-learning costs and dedicated work time for e-learning. The thrust of their argument was that suitably trained library staff could provide much needed guidance in these matters to both teachers and students.

Only one literature review, by Wofford et al[151], specifically looks at studies of CAL versus the traditional lecture format. This rather humourous publication examined 8 randomised controlled studies dating as far back as 1979. Only five of these specifically dealt with computer based interventions while the three older studies looked at lectures versus audiotape/pamphlet and "live" lectures versus videotaped lecture. Only one was of a multimedia presentation, the other 4 being multimedia textbook equivalents.

Wofford concludes that overall, the findings slightly favour the computer based lecture but add the important caveat that there may be publication bias towards the more novel medium. Echoing other commentators, Wofford also suggests that the

electronic lecture absorbed in the student's own time may increase the value of subsequent small group tutorials and, again, reference was made to the potential utility of "anytime, anyplace learning".

Trish Greenhalgh opens her 2006 review in the BMJ with a bold statement that few have made: "*computer aided learning is inevitable***"** and so "*planned and coordinated development is better than indiscriminate expansion***".** Further reasons cited for implementing CAL include:

- CAL is convenient and flexible i.e. anytime, anyplace learning.
- CAL has unique presentational benefits e.g. animations of complex processes.
- CAL can deliver personalised learning e.g. learning paced to suit the learner.
- CAL can deliver economies of scale.
- CAL based curricula may be more attractive to applying students.
- CAL can expand pedagogical horizons.
- CAL can achieve the ultimate goal of higher education i.e. link people into learning communities[152].

Greenhalgh's literature search yielded over two hundred results of which only twelve were prospective randomised controlled studies comparing CAL with traditional teaching methods. Greenhalgh stresses these were not directly comparable and most had significant methodological weaknesses. Overall, the outcomes of the trials showed either no benefit or only a modest benefit in the CAL groups.

Much the same can be said for David Cook's large meta-analysis published in JAMA in 2008[153]. This was the first meta analysis since 1994 on this subject and thus rather

overdue given the pace of technological change. This far reaching and exhaustive review looked at the net benefits of internet based CAL versus *no* intervention and unsurprisingly found CAL to be superior. Despite attempting to correct for the large amount of heterogeneity found, he could not discern a palpable advantage over non-internet based teaching methods but did at least establish acceptability and equivalence.

A related study by Cook in 2010[154] which used (one suspects) broadly similar data to construct a meta- analysis looking at what aspects of CAL are deemed to beneficial. He concluded that there was hard evidence to recommend interactivity, feedback and practice exercises in proposed CAL packages. As always, Cook emphasised the need to avoid media comparative studies in future.

In further attempts to delineate what works for CAL users, Ruiz and Cook[155] undertook a critical review in 2009 to examine the literature pertaining to the effectiveness of animations in CAL. Their conclusion was that not all animations are of an equal standard when assessing retention and transfer of information. They advise considering cognitive load theory and multimedia theory (Chapter 1) when deciding whether animations will help or hinder the learning process.

Heidi Chumley-Jones[156] split her systematic review of Web based Learning (WBL) into two major arms- evaluative and descriptive. Presumably recognizing the analytical difficulty of "unpacking" this dichotomy she subsequently subdivided the results into four more informative "domains":

1. **Studies evaluating knowledge gains**- mostly comprising studies involving pre- and post-test scores. Improving study design seemed to correlate with an absence of advantage of using WBL.

2**. Learner's attitudes**- Learners appeared to welcome WBL applications but with caveats about download speeds, poor interactivity and ease of use.

3. **Evaluation of efficacy of learning**- Only 2 studies in this domain were identified and only one which was well designed. It was concluded that WBL was more time efficient than reading a textbook objectively but subjectively, students *thought* it less efficient.

4. **Evaluation of costs**- Only one study in this domain which was very limited but opined that printing costs could be reduced with WBL.

Consistent with the age of the article, there was a wealth of descriptive studies peppering the four domains.

Finally, and most intriguingly, Wong and Greenhalgh employed a *qualitative systematic review* technique to ascertain what aspects of internet based medical education work, for whom and under what circumstances. The novel step in their approach was to gather the data and then adopt a "hypothesis-emergent" and "realist review" approach to analysis via (amongst other more traditional research techniques) brainstorming and "trying-on" candidate theories which best explained the phenomena observed.

The two main take home messages channelled by the accepted candidate theories are that internet based courses must engage their target group of learners to utilise the

technology and that learners greatly value interactivity. They then go on to suggest a set of five questions that educators ought to address in order to increase chances that the course will be seen as useful and an effective learning opportunity:

1. How useful will the prospective learners perceive the Internet technology to be?
2. How easy will the prospective learners find this technology to use?
3. How well does this format fit in with what learners are used to and expect?
4. How will high-quality human-human (learner-tutor and learner-learner) interaction and feedback be achieved?
5. How will high-quality human-technical interaction and feedback be achieved?[157]

Comparative studies

The literature search terms yielded 66 studies which were classified as comparative studies. Despite meeting the inclusion criteria, many studies were in very low volume circulation journals and involved very small numbers. The selection displayed below represents some of the better quality studies, with larger numbers and/or from larger circulation or specialist journals (Table 2.5):

Author	Aim	Study Type	No. of subjects	Outcome measure	Kirkpatrick level	Result
Devitt 1999 [158]	Comparison of CAL with PBL CAL & human teacher	RCT	90	Written test performance	2- Learning	CAL group significantly better than control
Shomaker 2002[159]	CAl vs lectures vs blended approach in parasitology	RCT	94	Pre-test & post-test	2- learning	All 3 groups similar. Pure CAL more efficient
Cox 2007 [160]	CAL compared with traditional teaching	Non-randomised	64	Qualitative data from written projects	2- learning	CAL and traditional teaching result in equal improvements in performance
Holt 2001 [161]	CAL compared with lectures	RCT	185	Pre-test & post-test MCQ	2- learning	CAL and traditional lectures result in equal improvements in performance
Bradley 2005[162]	CAL versus workshops in EBM	RCT	175	Post-test	2- learning	CAL group similar to traditional teaching for knowledge and skills
Devitt 2001 [163]	CAL compared with control	RCT	85	Pre-test & post-test MCQ	2- learning	CAL group performed significantly better
Davis J 2008[164]	CAL lecture compared with live lecture	RCT	229	Pre- & post-test	2- Learning	CAL group similar
Spickard 2002[165]	CAL lecture compared with live lecture	RCT	95	Pre-test and post-test assessment	2- Learning	CAL and traditional lecture result in equal improvements in performance
Taverner 2000[166]	CAL tutorial compared with live tutorial or video tutorial	Non-randomised	200	Post-test assessment	2- learning	Performance in post-test similar for all 3 groups. CAL more cost effective
Pereira 2007[167]	Blended learning Vs traditional teaching for	non randomised	134	Post-test	2- learning	Blended learning group significantly

	locomotor anatomy					better. No difference in preferences
Finley 1998[168]	CAL tutorial compared with classroom teaching	Non-randomised	40	Post-test assessment	2- learning	Post test performance similar for both groups
Schilling 2006[169]	Web based CAL module compared with traditional clerkship	RCT	240	Post-test assessment	2- learning	CAL group plus clerkship performed significantly better than clerkship alone
Ridgway 2007[170]	Text only web lecture compared with text plus sound web lecture	Non-randomised, controlled	50	Post-test assessment	2- learning	Significantly better performance on question stems pertaining to subjects taught using text plus audio
Nackman 2002[171]	Introduction of radiology CD-ROM to curriculum compared with exam results from previous didactic teaching session	Non randomised	98	Post-test exam	2- learning	Significantly better performance in CAL group
McDonough 2002[172]	Solo CAL package vs. face to face tutorial	RCT	37	Pre-test & post-test exam	2- Learning	Equivalent knowledge gains. CAL arm less enjoyable but more efficient
Williams 2001[173]	CAL tutorial compared with live lecture of equal duration	RCT	166	Pre-test and post-test assessment	2- Learning	No difference in performance between CAL and live lecture group

Table 2.5- Selected studies comparing CAL with other learning strategies.

As can be seen from table 2.4, all of these studies achieve a level 2 (increased learning) in Kirkpatrick's hierarchy of instruction[174] which has been adapted for medical education (Fig 2.2). The reason for this is not clear but may be due to the design complexity and ubiquity that CAL needs to achieve before level 3 and 4 outcomes are observable.

Fig 2.2- Kirkpatrick's hierarchy of instruction[175]

In addition, the overwhelming majority of studies demonstrate either no advantage or modest advantage of CAL over traditional teaching.

One trend that was noted when evaluating this subgroup is that there were more media comparative studies a decade or so ago when compared to more recent publications perhaps suggesting that others are realising the argument is largely over. The level of necessary rigour displayed in the conduct of such studies seems to increase with time too.

Williams et al[176], in 2001, looked at a large cohort of medical students learning psychiatry. He performed a single-blind RCT comparing both perceived and material advances in knowledge when comparing a standard psychiatry lecture to a computer based teaching package on CD-ROM of equal duration. Although the students who undertook the live lecture programme subjectively rated their knowledge and skills as greater than the CAL group this was not borne out by the post-test. This demonstrated that the level of factual knowledge was not significantly different between the two groups but did find a significant improvement in skills acquisition in the CAL group. This led to a slightly contentious conclusion that *"sometimes students may not know what is good for them."*

Further work on psychiatry students was undertaken by Michael McDonough in 2002[177] who, following a preliminary lecture, randomised a fairly small group of students to receive instruction in exposure therapy for phobia/panic via either a face-to-face tutorial or a solo CAL. Again, the post-test scores of knowledge gain were not statistically different (the tutorial group attaining marginally better results) but the students expressed significantly greater satisfaction with the tutorial even though the tutorial was less efficient and took five times as long to administer.

Accepting the idea that blended learning may be the way forward, Pereira[178] took a slightly different approach which was to compare different methods of anatomy teaching. In a non-randomised manner he exposed one group to traditional anatomy teaching and the other group to a "part-attendance" course which involved a significant portion of the course being delivered via computer in a self-directed fashion. The Blended arm achieved significantly better results in post-test but again

the students expressed no significant preference for the blended learning course over the traditional course. Pereira commented that although the blended learning course resulted in better test outcomes, it was considerably more labour intensive for the teaching faculty. This was in the face of relative student indifference and continued preference for written course materials.

One may argue that anatomy has a natural tendency to lend itself well to CAL based teaching given its visual nature but other less "visual" topics may also be suited to computer based teaching. A large randomised controlled trial conducted by Davis[179] in 2008 compared traditional lectures in Evidence Based Medicine (EBM) with a computerised lecture on EBM allowing the student to control the pace of delivery and skip to other sections. The pre-test and post-test results indicated that both groups significantly improved their knowledge in EBM to similar degrees thus supporting the view that CAL may demonstrate at least its equivalence in less visual subjects.

A converse argument would be that drier subjects such as EBM might be *equally unpopular* in CAL and lecture formats and that the old gold standard of small group teaching would show up the shortcomings of CAL. This is refuted to a degree by earlier work from Bradley et al[180] who performed a large and well constructed RCT directly comparing traditional face-to-face workshops in EBM with self-directed CAL of similar content. In this case there was equivalence in post-test scores and also in satisfaction with both teaching modalities. Bradley also suspects what others have suspected before him[181], namely that medical students are highly motivated and will learn effectively whatever the quality of teaching. As the variety of learning resources continues to mushroom, one has less and less reason to doubt this assertion.

A similar result was achieved in 2002 by Shomaker[182] but in this instance he took the novel 3 way approach of directly comparing lectures, pure CAL and a blended approach with each other when delivering a parasitology course. What he found was that all three groups performed similarly well on pre-test and post-test but the time taken to administer the blended approach was greatest followed by the lecture course followed by the pure CAL course. From this he concludes (again) that CAL is not inferior but is also a more efficient method of teaching and that blended learning approaches may risk overwhelming the student with options and thus may be less efficient.

Overall, most of the published comparative studies show either clear benefit over or at least equivalence with traditional didactic teaching within an undergraduate curriculum. The sticky issue of heterogeneity is ever present and one will always be asking the question "are these results transferable to what I am doing?" but the sheer volume and variety of comparative trials coupled with recent and useful meta-analyses[183] is reassuring in this respect.

Surveys or questionnaires pertaining to CAL use by medical students& teachers

There is an extensive body of literature evaluating and comparing CAL initiatives with more traditional methods and even more publications describing novel CAL initiatives. There is, however, a relative paucity of data pertaining to the computer usage habits of students and even less data looking specifically at their levels of access to the new media.

The database search yielded 22 articles which met the inclusion criteria, a selection of which are shown in table 2.6:

Author	Respondent	No.	Subject	Outcome
Moberg 1999[184]	Medical Schools	125	Institutional use of CAL	Limited use, more in preclinical school
Polyakov 2000[185]	Clinical teachers	246	Attitudes to IT and CAL in medicine	Respondents found IT useful and they advocate wider access. Less enthusiastic about CAL
Slotte 2001[186]	Finnish teachers & students	488	General IT use by educators and medical students	Widespread interest & enthusiasm for CAL & associated hardware
Sandars 2007[187]	Medical students	197	Use of blogs/wikis	High level of familiarity/use of blogs & wikis
Kennedy 2008[188]	Medical students	278	Use of CAL software/hardware	Widespread use among students of "core" items
Kerfoot 2005[189]	Medical Students & tutors	342	Response to introduction of plasma screens & broadband in tutorials	Universally positive impact of CAL hardware
Jastrow 2004[190]	Medical students	397	Use of IT, CAL and the internet for learning anatomy	High student demand for anatomy CAL- needs to be examination focused and locally relevant
Gormley 2009[191]	Medical students	269	Access to & confidence/skills in using IT & CAL	High levels of access and confidence/skills
Regan 2002[192]	Medical students	42	CAL/It usage patterns in primary care	Positive views in longer attachments. Less useful on short attachments
De Leng 2006[193]	Medical students	355	Perceived usefulness of a virtual learning environment	General approval of VLE addition o tutorials- adds to learning
Cardall 2008[194]	Medical students	204	Use of recorded lectures vs live lectures	Majority use live lectures but majority find recorded lectures equally or more valuable
Peterson 2004[195]	Medical students	116	Monitoring usage of a digital textbook	Rapid adoption of digital textbook and other electronic resources
Dorup 2004[196]	Medical students	1159	Internet & computer availability/usage over 5 years	High usage of mail and internet- rising with time

Table 2.6- Surveys/questionnaires of CAL usage by medical students/teachers

An early survey of computer availability and usage amongst Danish medical students between 1998 and 2002 was carried out by Dorup[197]. The findings indicated a dramatic increase in the availability of IT resources over a five year period. 30% of polled students expressed a preference for CAL as their primary learning resource whilst 80% viewed CAL as a useful supplement. Many teachers on the faculty were reluctant to embrace CAL, which was in stark contrast to the widespread acceptance by the students.

These findings were largely replicated by Slotte's Finnish study[198] which reported great enthusiasm for the "new media" and increasing levels of access to hardware. It was noted, again, that teachers used It more often in their research work than in their teaching activities.

Contrast this with an earlier report by Moberg et al writing in Academic Medicine[199]. Moberg's survey is a follow up to numerous earlier national recommendations that U.S. medical institutions increase their commitment to educational technology within their programmes. What he found was that by 1998, institutions had made "limited progress" in accomplishing these goals. He did however concede that the level of provision was increasing rapidly at the time of writing and cautioned that institutions needed to have a strategy that would meet the IT based educational needs of future medical students.

In 2004, Jastrow and Hollinderbaumer wrote in the New Anatomical Record[200] about the distribution of almost 400 questionnaires to clinical and preclinical

students at a German medical school. They reported that 95% of the students polled had access to a personal computer of which 85% had access to the internet. The freetext sections of their survey suggested a "*high student demand for computer-aided instruction and anatomy applications offered on the Internet and on CD-ROMs. The students' main focus of interest was found to be examination-relevant material and supplemental study material for courses offered locally*."

A 2004 study by Peterson et al. monitored second year medical students use of a digital textbook called Up to Date© during their transition to the clinical years[201]. This prospective survey identified a rapid rise in the uptake of Up to Date and other digital learning resources to a point where more than 85% of respondents identified electronic media as their primary resource for clinical information. Most respondents also said that they used the electronic resource daily and usually required less than 15 minutes to obtain the clinical information they needed.

More recent surveys seem to reflect the fact that such students are beginning to adopt and positively evaluate even newer technologies . Cardall[202] reported in 2008 that students were given the option of attending live lectures and/or staying at home and accessing the lectures in a pre-recorded electronic format over the internet. Although attendance at lectures was still high, the majority of respondents stated that they actually preferred being able to pause and fast forward the pre-recorded internet lecture, ostensibly to increase the efficiency of their learning.

This apparent high level of savvy and confidence in IT hardware to deliver CAL effectively is reflected in Gormley's[203] 2009 survey which looked at student demographics and interrogated their level of access to IT and their perceived level of IT ability. He also probed into students experiences and attitudes to e-learning for clinical skills. What he found was that students appear to have good levels of access to IT equipment on and off campus. In addition he discovered that students felt that e-learning had made a positive impact on their learning of clinical skills and that CAL was comparable to traditional methods of teaching clinical skills.

The sheer variety of platforms that students can now use to explore CAL was revealed by Kennedy's[204] 2008 survey of Australian medical students which revealed that students have near universal access to mobile phones, memory sticks, PC sand broadband. He described it as high levels of access to the point of being *"entrenched"* within the lives of the students. The finding that PDA use was relatively low was a little incongruous but may be explained buy the fact that many mobile "smart" phones now effectively perform the functions of a PDA such as surfing the internet, checking email and storing media. Although hardware access and confidence in usage was universal, there was significant heterogeneity in what students actually used it for. Within one year group, some students were regularly using podcasting, blogging and social networking for learning while others were engaged in more prosaic activities. It is interesting to note that the students in junior years were more *au-fait* with advanced activities than their seniors- perhaps reflecting the pace of change.

Looking chronologically at these surveys reveals a general trend. Earlier articles show a relative lack of access to and familiarity with CAL hardware and software both amongst educators and students. Subsequent articles are illustrative of the pace of change with students becoming much more computer savvy, having almost universal access to ever cheaper hardware and using it to access CAL in a variety of ways.

Descriptive studies and evaluations of CAL initiatives

A total of 103 articles were identified in this group. This group was particularly heterogeneous in its content and there appeared to be a subgroup of studies which (having significant relevance to this thesis) dealt with the implementation/delivery of CAL initiatives to medical students. The general group was examined and a representative selection of studies are shown in table 2.7 while selected examples of studies describing implementation/delivery are shown in table 2.8.

Study	**Type**	**Evaluation method**	**Kirkpatrick level**	**Conclusion**
Inwood 2005 [205]	Descriptive. Development of anatomy CAL by students	Post exposure questionnaire	1- satisfaction	CAL useful and acceptable to students but not often accessed
Granger 2006[206]	Descriptive. Use of anatomy CAL prior to dissection sessions	Pre & post exposure questionnaire	1- satisfaction	CAL useful and acceptable as preparation for formal teaching
Stromso 2004 [207]	Study of changes in learning approach after introduction of CAL assisted Problem Based Learning (PBL)	Pre & post exposure questionnaire of learning styles	1- satisfaction	CAL did not affect learning styles but diminished the importance of the tutor and student group
Jacobs 2003 [208]	Descriptive telemedicine CAL study. Virtual patient simulation	None described	N/A	Telemedicine CAL module potentially useful for provision of teaching to remote groups
Reid 2000 [209]	Descriptive. Embedding of CAL pathology teaching into didactic course	Post exposure questionnaire	1- satisfaction	CAL useful and easy to use but seen as complimentary to didactic teaching rather than replacing it.

Gomez-Arbones 2004[210]	Descriptive. Study of web usage and satisfaction with a cardiology CAL package	Web usage statistics and post exposure satisfaction survey	1- satisfaction	Highly rated by students but only as an adjunct to formal didactic teaching
Hulsman 2004[211]	CAL demonstration of communication skills	Post exposure assessment	2- knowledge	CAL well received and good post-exposure examination results
Wahlgren 2006[212]	Descriptive. Development of interactive CAL for teaching dermatology and venereology	Post exposure questionnaire	2- knowledge	CAL well received by students and extensively accessed. NB No improvement in end of course examination.
Roesch 2003[213]	Descriptive. Development of interactive dermatology teaching program using CAL	Post exposure questionnaire	1- satisfaction	High level of acceptance and increased level of interest in medical education software
Colsman 2006 [214]	Descriptive. Outlines functions of online tutorial in immunology	Post exposure questionnaire	1- satisfaction	Students expressed high levels of satisfaction with CAL module
McLean 2000 [215]	Descriptive. Reviews introduction of 3 types of CAL in parallel with traditional course in histology	Post exposure questionnaire	1- satisfaction	Students expressed generally high levels of satisfaction with CAL but more for some varieties than others. Divided in opinion about CAL replacing traditional microscopy entirely
Mclean 2002[216]	Descriptive. reviews introduction of WebCT (a VLE) into a modern medical curriculum	Post exposure questionnaire	1- satisfaction	High levels of satisfaction expressed by students
Teichman 1999[217]	Descriptive. Introduction of interactive urology CAL	Post exposure questionnaire. Pre and post-test examination	2- knowledge	High level of satisfaction and increased post-test scores on examination
McLay 2001[218]	Descriptive study of student exposure to CD-ROM and web based neuropathology teaching material	Post-exposure questionnaire and assessment of examination results	2- knowledge	High level of satisfaction from students and improved exam results compared to controls
Maxwell 2006[219]	Descriptive study of the introduction of CAL to facilitate awareness and learning of pharmacology and therapeutics	Post-exposure questionnaire and logging of server statistics	1- satisfaction	High level of satisfaction among users as well as correspondingly high number of website “hits”
Sloan 2002[220]	Descriptive, small scale study of medical student responses to a CD-ROM tutorial in pain control	Post exposure questionnaire	1- satisfaction	Good levels of satisfaction with ease of use and content.

Patel 2006[221]	Descriptive study of designing microscopy slide atlas and responses of students	Post exposure questionnaire and server statistics	1- satisfaction	Significant levels of web "hits" and generally positive feedback from students surveyed.
Guerandel 2003[222]	Appraisal of a VLE (Virtual Learning Environment) in psychiatry	Post exposure questionnaire	1- satisfaction	High level of satisfaction reported with encouragement from students for further implementation
Reimer 2006[223]	Descriptive study of introduction of rheumatology CAL module into curriculum	Post exposure questionnaire plus examination results	2- knowledge	Better examination results for students processing more CAL cases as well as very positive feedback
Wilson 2006[224]	Descriptive study of rheumatology case based CAL	Post exposure questionnaire	1- satisfaction	CAL highly rated by subjects as being realistic and relevant
Zebrack 2005[225]	Web based CAL curriculum for women's health	Post test questionnaire, examination and usage logs	2- knowledge	Cal preferred to lectures and "excellent" post-exposure examination results
McNulty 2004[226]	Evaluation of anatomy CAL with web usage statistics	Measurement of usage statistics and correlation with exam results	2- knowledge	Statistically significant positive correlation between web usage of CAL module and exam result
Mutter 2005[227]	Purely descriptive study of minimally invasive surgery website	Number of hits on website	N/A	Significant increase in number of website hits over time

Table 2.7- Descriptive studies and evaluations of CAL initiatives

A glance at table 2.7 will reveal the most predominant feature of descriptive/ evaluative studies which is that most of them involve the evaluation of CAL as a "value added" product into the curriculum and as such the response is overwhelmingly positive from highly motivated students keen to have more resources. On this point at least, one can say that the literature has reached saturation point. Even then, a number of authors point out that their students view the intervention as a supplement rather than a direct replacement for more traditional teaching.

One trend observed with the reviewed articles is the large number that emanate from low circulation journals, journals in e-print only or journals with a "web article" section. Many also hail from subspecialty journals with larger circulations.

Descriptive/evaluative articles appeared fairly frequently in the leading Medical Education periodicals around and before the millennium but have been less frequently published in recent years. One can only assume that such "show and tell" pieces lack methodological rigour and that the sheer heterogeneity of the approaches used limit their generalisability.

Study	**CAL initiative type**	**Timescale**	**Outcome**
Hamilton 1999[228]	Various: virtual patients, study guides, tutorials and CAL based assessments	5 years	Over 150 IT based resources integrated into curriculum. Well received and still in use by students
Wheeler 2003[229]	Online curriculum in anaesthesia- various components	2 years	Online curriculum and testing now integral to institutional teaching structure and well received by teachers. More so by students
Kerecsen 2002 [230]	Provision of teaching and testing resources in pharmacology. Evolution of CAL over 30 years	30 years	Complete integration into curriculum. Very well received by students who post higher than average examination results in pharmacology
Lindell 2006[231]	Provision of Nutrition of CD-ROM and development of online module	10 years	CD-ROM distributed to all US medical schools over 10 years and well received.
Hammoud 2002[232]	Online provision of Ob-Gyn self-test questions instead of on floppy disc	1 year	Near universal changeover to the web-based format
Velan 2002[233]	Online provision of formative self-assessment module in pathology	5 years	Complete adoption of module and good student feedback
Zary 2006[234]	Development and introduction of web based “Virtual Patient”	5 years	Complete adoption of module in own institute and licensing to 10 other medical schools worldwide. Positive survey feedback from students and faculty
Blake 2003[235]	Conversion to digital format of histology slides and distribution on CD-ROM	2 years	Students no longer use microscopes and access all histology via the CD-ROM. Strong support from students and faculty

Table 2.8- Articles which describe the implementation/delivery of CAL initiatives

Kerecsen[236] et al can clearly lay claim to being the ultimate early-adopters with over 30 years experience of teaching Pharmacology to Kansas medical students. Their evolutionary approach to CAL began with mainframes, through microcomputers and now their program resides on the Web. The challenge of changing technologies, according to the authors, was mirrored only by the challenge of changing teaching methods.

One can guess that technological obsolescence also at least partially contributed to Hammoud's [237]successful changeover from floppy disc to the web.

Logic and economies of scale may also be in part responsible for Blake's[238] successful transition from standard histology slide provision to digitised images. The images are static and unchanging and a good representative slide can be replicated infinitely, thus aiding standardisation.

With almost no exception, all articles describing implementation or delivery of CAL initiatives were success stories. One can imagine that such studies are exquisitely vulnerable to positive reporting bias and this may be something of a missed opportunity on the part of journals. It would be just as instructive, if not more so, to learn of initiatives that had signally failed in order to see what factors had been contributory.

Review Limitations

During the literature review a number of difficulties and limitations were encountered in collection, classification and analysis of data:

- The field of medical education research acts as an umbrella term encompassing the disciplines of biomedical research, social sciences research as well as research in the field of psychology. The need to cast the net wide risked missing high quality data in one or two large but narrow databases.
- The large number of synonymous terms alluded to earlier (e.g. CAL, CAI, e-learning, blended learning) made the search process cumbersome. As a result, it was necessary to identify the most commonly used terminology when defining search terms. Although the search terms were fairly exhaustive, the possibility remains that omitting some more obscure terminology may have resulted in a lower yield.
- In view of the large number of databases interrogated, it was not deemed practical to look specifically for non-peer reviewed "grey literature". This may result in potentially useful articles having been missed.
- Searching databases such as Medline using appropriate strategies has a high yield of appropriate articles but may still miss a significant number.[239]
- By its very nature, much published research in medical education uses mixed quantitative and qualitative methods for data collection and analysis. This served to make subdivision and classification of articles into a specific type extremely difficult. Many studies would not only evaluated student feedback

but also assessed post exposure examination performance. Similarly, many studies implemented unorthodox control groups that were not directly comparable in size or were not entirely representative. As a result, the publications were categorised based on what appeared to be the dominant methodology implemented and which made the greatest contribution to the conclusions drawn from the study. This may have resulted in an overlap of themes with some articles belonging in more than one sub-grouping.

Discussion

A review of the published articles reveals some important themes:

The literature reviews stressed that many of the studies reviewed were methodologically flawed or had insufficient statistical power to draw meaningful conclusions about the value of CAL. Many also commented on the barriers faced by those wishing to introduce CAL into the modern medical curriculum including financial constraints, resistance from faculty and students suspicious of CAL initiatives. Despite these reservations, and the failure of most studies cited to demonstrate a clear advantage for CAL, the overall impression gained from the literature reviews is that CAL has an emerging place in the delivery of a medical curriculum as part of a blended learning experience.

Trials that directly compared CAL with didactic teaching showed that in most cases CAL was well received but resulted in equivalent or only marginally better outcomes (mostly assessed in the form of exam results). Given the large number of such studies,

it seems reasonable to extrapolate that CAL offers equivalence if not clear superiority to more traditional educational approaches.

The possibility of positive reporting bias cannot be discounted however the results are most likely related to what is known as the "*no significant difference phenomenon*". This catchphrase was popularised by TL Russell's 1999 publication *The No Significant Difference Phenomenon as Reported in 355 Research Reports, Summaries and Papers*[240]. A companion website[241] to this book lists hundreds of studies that have shown no significant difference in academic achievement between distance learning resources (including CAL) and traditional face to face teaching. This builds upon evidence (discussed in chapter 1) of other media such as the television, radio and motion picture failing to replace classroom teaching.

Russell's comments do rather beg the riposte "*no difference in what?*" What is it that we are trying to measure here? Is it enough to content ourselves that CAL is only equivalent and no better? Perhaps a better approach would be to acknowledge the fact that when dealing with highly motivated adult learners, the end result may well be the same *at this point in time* but accept that CAL is "*inevitable*" (to quote Greenhalgh). From this point it would move the game forward to analyse what aspects of CAL work and what aspects are less successful in much the same way as posited by Mayer's Theory of Multimedia Learning. By adopting this iterative approach, we may be in a future position to draw some valid conclusions about which types of CAL work best (and under what circumstances) rather than the jaded question of whether it works at all.

One possible solution which has its roots in Instructional Design is known as Design Research[242] whose purpose is to provide design guidelines for creating and implementing effective online teaching. In contrast to media comparative studies, design research :

- Focuses on broad-based, complex problems critical to education
- Involves intensive collaboration among researchers and practitioners
- Integrates known and hypothetical design principles with technological affordances to render *plausible solutions* to these complex problems
- Conducts rigorous and reflective inquiry to test and refine innovative learning environments as well as to reveal new design principles
- Requires long-term engagement that allows for continual refinement of protocols and questions
- Maintains a commitment to theory construction and explanation while solving real-world problems[243]

The somewhat limited literature that surveyed students' use of CAL indicates rapidly increasing levels of both access and usage. The student's demand for CAL-based material appears to be driven by learning goals such as examinations rather than curiosity. Some studies recognised that students were concerned about CAL supplanting traditional face to face teaching. Because of the rapid evolution of technologies within the digital information age, and the time taken to conduct, submit and publish a trial, it is likely that much of the published literature is dated and fails to account for the evolution of student attitudes to multimedia and their changing levels

of access to media rich learning environments. The trend certainly is towards universality of access in the developed world.

Descriptive studies outlining the integration and implementation of CAL were few in number but suggested that once CAL is embedded, this model of delivery can be successfully integrated into a curriculum where it can evolve further. Key factors influencing successful implementation includes appropriate funding, ease of use, relevance to learning goals and the enthusiastic acceptance and support of CAL initiatives by faculty members.

It is interesting to note that the literature is dominated by certain disciplines. Those which stood out included histopathology, anatomy and dermatology. These subjects are all visual in character and probably lend themselves best to the development of multimedia.

Authors of review articles appear to reach a consensus that CAL is unarguably a powerful teaching tool but also conclude that an evidence based approach is necessary when deciding which CAL applications are suitable. The need for evidence generates some key questions:

- Is there a gold standard study design to test the value of a CAL application?
- How much weight is there in systematic reviews, randomised controlled trials comparing CAL with other methods of content delivery? Is it simply a question of student preferences rather than the interpretation or conduct of more profound research?

- What are the outcome measures that determine the success of a CAL intervention? Should success be judged by student approval, improved retention, improved understanding, or should outcomes be determined in the longer term by measuring clinical outcomes and ability to convert learning into better patient management?
- CAL applications provide the potential to present and teach the same subject in many different ways. Given the potential scope for creative innovation and the variety of technologies available to deliver the media, is it possible to reasonably compare CAL interventions or generalise from single studies assessing their utility?

Most published evaluations of CAL, be they comparisons with traditional teaching methods or as a standalone intervention, implement a mix of quantitative and qualitative research methods. This hybrid body of knowledge makes generalisation difficult.

It would seem that when setting out to compare CAL interventions with traditional teaching methods, "comparisons are odious"[244]. By popular consensus CAL is here to stay. More productive use of research time and resources may involve examining the efficacy of one form of CAL versus another or, even better, constructing rigorous qualitative studies looking at CAL design, integration and implementation as well as studies that describe the tools necessary for CAL to be successful[245]

Chapter 3- Developing *AnswersIn*

Introduction

In the first chapter, much attention was focused on the concepts of:

- How adults learn
- Why adults learn
- How multimedia learning theory and Instructional Design (ID) can help in the creation of effective CAL programs
- The importance of a well designed user interface

Also outlined in chapter 1 was the growing gap between the rising expectations of an increasing number of medical students and the potential failure to meet these expectations by institutes for higher education facing financial constraints and reduced availability of teaching staff.

What became apparent was a provision gap that might meaningfully be filled by CAL provided that it conformed to the principles of Adult learning and was developed in accordance with the ADDIE model central to Instructional Design (ID).

The second chapter consisted of a literature review which served to delineate the current body of evidence as it pertains to the provision of CAL to medical students. The literature was of pivotal importance in establishing some general principles :

- CAL (in its many different forms) is as good as traditional methods of teaching medical students
- With time, access to hardware that will facilitate CAL has become almost universal

- Medical students respond positively to CAL if it not perceived as a threat to their face-to-face teaching
- Modern medical students are more familiar and comfortable with the hardware and software used to provide CAL than perhaps their teachers and institutions

At The Royal Free and University College Medical School (RFUCMS) there have been various innovative attempts to improve the teaching experience for clinical students by introducing new technologies. It is not clear if their introduction has been the result of an analysis of sound pedagogy or economic expediency.

A good example is that of "Livenet". In order that only one lecturer would be required for the delivery of a lecture to all three medical school campuses (Hampstead, Bloomsbury and Archway), a lecture broadcasting system called Livenet was introduced.

At a prearranged time, clinical students from all three campuses are required to attend a networked lecture venue at their campus. There is only one lecturer who lectures directly to the students at his/her home campus. Students from the other two campuses receive a live video and sound feed via a high speed internet link. The projection screen at the distant campuses displays the lecturer on camera as well as the PowerPoint® presentation.

Interactivity is possible from each location using a roving handheld microphone available in the lecture theatre. When the lecturer asks a question, one of the students is expected to answer via the microphone which transmits the answer across all three campuses. Similarly, the microphone is used if the student has a question for the lecturer. Students have commented on a number of technical and other difficulties with Livenet:

- Poor quality sound.
- Poor quality video and the lecturer being "off- spot" with regard to the fixed camera.
- A disconcerting delay in synchronisation between audio and video.
- If the lecturer at campus A asked a question and a student at campus B answered, the discourse is often inaudible to the students at campus C.
- Livenet lectures are frequently cancelled and the designated lecturer is often replaced at short notice by a substitute.
- Often, little or no attempt is made by the lecturer to engage the students on the remote campuses[246].

An audit of Livenet attendance demonstrated that at the beginning of a 10 week teaching block, 25 of 30 (83%) students at the Hampstead campus attended the first Livenet lecture. By week five this number had fallen to 14 of 30 (47%) and by week 10, only five (16%) students attended.[247]. Some of these attendees were observed to use the lecture time to converse and drink coffee, safe in the knowledge that the lecturer at the distant home campus was oblivious. End of block feedback about Livenet has been unfavourable[248].

There are CAL programmes in place which the students use on a regular basis. These applications divide into 3 broad categories:

- Those that facilitate the organisation of teaching e.g. VLEs (Virtual Learning Environments) such as WebCT®[249]. RFUCL medical students use WebCT during their preclinical biochemistry course.
- Those that allow the student to perform self-assessment e.g. LAPT® (London Agreed Protocol for Teaching)[250] which is a certainty based multiple choice teaching module popular with RFUCL clinical students.
- Those that provide core information to students e.g. online copies of PowerPoint© presentations.

Project Aims

The aims of this study were:

1. To design a computer-based multimedia platform, built around core topics in gastroenterology, that would deliver a multimedia learning experience to undergraduate medical students based of the key principles of good "adult" learning and Instructional Design including:
    - A novel interview based delivery method.
    - A combined audio and visual experience to enhance the learning process[251].
    - Comprehensive coverage of a subject thereby providing a prime learning resource.
    - An intuitive interface which would preclude the need for prior training[252].

- The ability to access the information at a time and place of the learner's choosing[253] i.e. "*anytime, anyplace learning"*.
- The ability to deliver "*just in time*" and "*just enough*" learning[254].
- The ability to control the pace of learning[255].
- The opportunity to ask questions and interact.

2. To describe in detail the steps involved in the creation of a multimedia platform that would fulfil these criteria.

This and subsequent chapters will demonstrate the development of the *AnswersIn* resource within the **ADDIE** Instructional Design framework thus:

1. **Analysis**

- Introductory chapter examining principles of adult learning, ID and multimedia theory
- Literature review to demonstrate current "state of play" as regards all aspects of CAL provision to medical students
- An examination of the current curriculum for undergraduates in medicine at Royal Free & University College Medical School with emphasis on a target group of students studying gastroenterology in their first clinical year
- A survey of clinical medical students examining their access to and use of multimedia computer equipment

2. **Design**

- Creation of a novel multimedia computer program designed to provide core content in gastroenterology to the target group of students
- Adherence to the principles of adult learning with emphasis on self-directed "*anytime, anyplace*" learning
- Adherence to established guidelines regarding best practice in multimedia design

3. **Development**

- Conversion of validated core content in gastroenterology to interview style scripts and subsequent recording
- Embedding of edited audio into Flash environment with synchronous text and/or graphics/animations
- Creation of additional relevant visual content
- Facility for student to test themselves
- Facility for asking questions within an asynchronous learning environment

4. **Implementation**

- Initial pilot scheme with exposure to limited number of students (prototyping) via distributed CD-ROM
- After necessary modification, conversion of resource to availability on intranet
- Distribution via intranet to all clinical students studying gastroenterology within a single campus and subsequent dissemination to all such students across all 3 campuses

5. **Evaluation**

- Use of post- pilot study focus groups to evaluate prototype via qualitative and quantitative methods and recommend alterations
- Use modified pilot study questionnaire to serially evaluate responses of larger group of students once resource placed on intranet. Assess responses quantitatively and qualitatively.
- Utilise web-tracking software to quantitatively analyse patterns of use of the resource by target student body
- Quantitatively evaluate the effect of advertising the resource on its uptake by target students
- Utilise qualitative and quantitative methods to test hypothesis
- Reflect upon the development "journey" in order to create learning points for future researchers

Materials and Methods

About the medical students

University College London is the largest college within the University of London with a total of over 19,000 graduate and undergraduate students. At any one time approximately 1800 of these students are undergraduates studying for the MBBS medical degree at RFUCMS (Royal Free and University College Medical School). The medical school has an annual intake of 330 and offers undergraduates a six year course (five years formal training with an added year to pursue an intercalated BSc in a subject of their choice).

The basic structure of the course is divided into "phases" as described below in table 3.1.

Phase 1
Science and Medicine

YEAR ONE

Foundations of Health and Disease
Infection and Defence
Circulation and Breathing
Fluids, Nutrition and Metabolism

YEAR TWO

Movement and Musculoskeletal Biology
Neuroscience and Behaviour
Endocrine System Regulation
Reproduction, Genetics and Development
Cancer Biology

Phase 2
Science and Medical Practice

YEAR THREE

General Medical Specialities (GHEDNOH)
General Medicine and Medicine in the Community
Care of the Older Person/Orthopaedics and Rheumatology

YEAR FOUR

Women's Health (Obstetrics and Gynaecology)/Communicable Diseases
Neuroscience and Behaviour (Neurology and Psychiatry)
Family and Child Health (Paediatrics and General Practice)

Phase 3
Preparation for Practice

FINAL YEAR

Medical and Surgical Departments of a District General Hospital (DGH)
Accident and Emergency Department of a DGH
General Practice
Two clinical specialities of the student's choice
A period of elective study either in the UK or abroad
Shadowing the post that will be taken up on qualification

Table 3.1.[256]- Structure of the RFUCMS MBBS course

From phase 2 onwards, hospital based teaching largely occurs on three separate campuses:

- The Bloomsbury Campus students are based University College Hospital
- The Hampstead campus students are based at The Royal Free Hospital
- The Archway Campus students are based at The Whittington Hospital

Periodically the student firms rotate between the three core campuses as well as to other associated University Hospitals, predominantly in the North London region.

The GHEDNOH module

During their third year of study, all medical students rotate through a 10 week general medical specialties module known as "GHEDNOH" (gastroenterology, hepatology, endocrinology, diabetes, neurology, oncology and haematology). The GHEDNOH students are divided up into three groups and each group attends one of the three main campuses.

In the academic year, each campus accommodates four sets of around 30 students and each block lasts for 10 weeks. The timetable is punctuated by holidays and a one week pathology course between each 10 week block.

Students sit a written examination at the end of block two and block four. In addition, locally organised clinical examinations are held in week 10 of every block.
At each campus there is an organising consultant who is responsible for coordinating the students and teachers. This consultant is supported by an administrative assistant.

The three campus GHEDNOH leads in turn, report to an overall GHEDNOH lead in Bloomsbury who liaises with a central curriculum committee.

During the GHEDNOH block, students are expected to participate in a wide variety of learning activities including lectures, seminars, tutorials, ward rounds, clerking patients and attending accident and emergency with the on-call medical team. Communication between the coordinating team, students and teachers is facilitated by email. All medical students have a UCL logon and password which allows access to email, the internet and other resources. At their induction, GHEDNOH students are asked to access their email twice daily in order to learn of any changes to teaching arrangements.

At the end of the module, students are interviewed individually to discuss their progress and are also asked to complete an anonymous online questionnaire asking about various aspects of the module, and providing a rating of the experience.[257]

The Hampstead Campus GHEDNOH students were the main study subjects for the initial phases of the study which was later followed by a roll out to all GHEDNOH students across all three campuses.

Application development process

Core Development Team

- OE- Professor Owen Epstein- project leader
- NK- Dr Nasser Khan (author)- research fellow & project coordinator

- TR- Mr Tim Rayne- office editor
- FF- Mr Fanky Fu- multimedia content integrator

Script generation

The gastroenterology topics were chosen from a previous survey of favoured topics amongst a group of 50 GPs and 50 specialist gastroenterologists, as part of the Map of Medicine®[258] project. For each topic, a question and answer radio-style interview script was authored by OE and NK. Evidence based source material was obtained from specialist text books, peer reviewed journal articles and reviews, and reliable internet sites (E-Medicine[259] and Up-to-Date[260]). A reverse role dialogue model was composed around each topic with the student asking the teacher the questions that teachers usually ask their students. An example is given in Appendix A.

The authors used a conversational, radio-style interview model designed to hold the listener's interest.

The following rules were applied when writing the scripts:

- Both questions and responses should be precise and as far as possible, simulate a natural conversation.
- Both the interviewer and interviewee should introduce themselves and the interviewer should set out clearly at the beginning, the subject of the interview.
- Each script should be no longer than 2500 words and it was calculated that when read aloud at a reasonable pace, this would result in an interview lasting approximately 20 minutes or less.

- Scripts should aim, as far as possible, to provide appropriate depth and breadth.
- Scripts should have frequent recaps and summaries, particularly when difficult subjects are being dealt with.
- Areas of clinical controversy should clearly indicate when a personal view was being offered.
- Scripts should be clinically relevant but wherever possible, applied basic science should be seamlessly integrated to help understanding of the topic.
- To ensure that the audio could be used independently of the visual content, no verbal reference to pictures or animations were included in the scripts.

Each of the scripts completed by either OE or NK was read, reviewed and edited by the other author. Any changes were agreed and the script finalised before being approved by TR.

Recording the Interview

Once final script edits were complete, an interviewer and interviewee were invited to rehearse the script prior to recording. Care was taken to instruct both teacher and learner of the need for eloquence, intonation and a sense of engagement. Initial attempts to record the interviews at the hospital proved difficult for both technical and sound proofing reasons, and an early decision was made to record a series of one hour sessions in a professional recording studio (UCL Media Centre and Air Studios[261]).

The raw recordings were edited to remove pauses, errors, page turns and other extraneous noises, and a digital audio file was mastered as a *.wav* file on a CD-ROM. The CD-ROM was then passed to the content integrator (FF), who undertook a final edit before converting the .wav file into a more memory efficient MP3 format.

Bulleting and Storyboarding

Whilst the audio was being recorded and edited, NK and an editorial assistant converted the original reading script into a standard style sheet, each displaying a title question followed by bullet point answers (see Appendix B). This compilation was then used for synchronous display with the audio on the PC screen (figure 3.4).

Relevant images for inclusion with the bullet pointed text were sourced by NK and permissions for use were obtained for all copyright material. The point at which each image was integrated was indicated on the bulleted text using red highlighted text (see Appendix B).

Where animations were required, NK worked closely with FF who produced the animated sequences from rudimentary diagrams (see Figs 3.5, 3.6 and 3.7). The style of the animations was standardised. The point of display of animated images was synchronised with the audio in the same manner as described for the static images. The final storyboard, including questions, bullet points, illustrations and animations was again edited and approved by TR and the compiled bullet points were converted into the Portable Document Format (PDF©) for later inclusion in the program.

Galleries

In addition to the illustrated audio interviews, content was added in the form of topic-related photo, histology and radiology galleries (Fig 3.8). The aim of the galleries was to supplement the images in the main body of work and to aggregate them in an album style so that they would be available for browsing and quick revision.

OE and NK decided which photo, radiology and histology images would be suitable for inclusion in the galleries. Permissions were obtained for all copyright material. The photo images were annotated by NK and approved by OE. The radiology and histopathology images were annotated by a radiology SpR (KS) and histopathology SpR (RS) respectively.

Self Assessment Virtual Viva

Topic specific virtual viva questions and their answers were scripted by NK and were designed to test retention of core knowledge which had been transmitted during the course of the interview. The number of questions was generally limited to 6-8 and OE approved the content of the questions.

Integration, Further Editing and Proofreading

Once the audio had been edited and the screen bullets finalised, the content integrator (FF) proceeded to merge the two into a Flash© presentation within a carefully designed and custom built template. The audio track set the pace for the screen changes. Each audio question was synchronised with a text display of the same question along the upper border of the screen and each bullet point was synchronised to appear in sequence with the teacher's response (fig 3.4).

The integration included the development of the photo, radiology and histology galleries and virtual vivas, each accessed from a screen icon and the PDF for each topic was accessible using the same design.

Once a topic had been fully integrated, further checking of spelling, timing and synchronisation was undertaken by NK, TR and OE. Finally, NK created a Web Log ("Blog") to provide on-line student support.[262]

The production and editorial process was repeated for all twelve topics in gastroenterology and the entire module was titled "*AnswersIn* Gastroenterology".

Distribution and Dissemination

When complete, the *AnswersIn* Gastroenterology module was made available in two formats:

- CD-ROM- The module was burned onto CD-ROM and enabled with an auto-run feature which automatically loaded and displayed the introductory screen when the CD was inserted into the PC
- Internet Website - With the assistance of the UCL IT team, *AnswersIn* Gastroenterology was made available through the university server[263]. All UCL staff and students issued with an IS (Information Services) username and password, could gain access *AnswersIn* from any Windows PC connected by broadband to the UCL computer network.

Results

Over a twelve month period over 8 hours of audio were recorded, integrated and synchronised within the template (table3.2).

Topic	Running time
Artificial nutrition	
Introduction	7m 46s
Enteral and parenteral	7m 41s
COBH	10m 41s
Colon polyps	
Polyp biology	12m 03s
Clinical aspects	20m 40s
Crohn's	
Introduction	14m 14s
Clinical features	11m 58s
Investigation	8m 40s
Management	14m 39s
Further management	9m 39s
Surgery	8m 28s
Perianal disease	10m 47s
Dyspepsia	
Introduction	8m 26s
Non-ulcer dyspepsia	11m 40s
Duodenal ulceration	12m 23s
Gastric ulcer *H pylori* positive	6m 48s
Gastric ulcer *H pylori* negative	4m 59s
Dysphagia	
Introduction	7m 30s
Assessment	7m 35s
Management of oesophageal strictures	13m 43s
Motility disorders	10m 16s
Haematemesis and melaena	
Haematemesis and melaena	12m 50s
Non-Variceal bleeding	6m 39s
Variceal bleeding	12m 03s
Heartburn	
Introduction	13m 06s
Complicated heartburn	10m 38s
Barrett's 1	6m 38s
Barrett's 2	8m 36s
Irritable bowel syndrome (IBS)	
Introduction	6m 51s
Causes of IBS	13m 37s
Clinical features	11m 14s
Treatment of IBS I	7m 28s
Treatment of IBS 2	10m 40s
Malabsorption	
Background to Malabsorption	13m 46s
Investigation of Malabsorption	14m 28s
Background to Coeliac disease	13m 07s

Management of Coeliac disease	9m 18s
Rectal bleeding	
Uncomplicated rectal bleeding	11m 11s
Haematochezia	10m 28s
Ulcerative colitis (UC)	
Introduction and clinical features	7m 15s
Investigation	13m 45s
Patient education	6m 15s
Assessing severity	10m 10s
Treatment of mild to moderate disease	12m 55s
Treatment of severe disease	13m 30s
Surgical management	10m 00s

Table 3.2- Table of *AnswersIn* contents

The total duration of major topics ranged from 10 minutes and 41 seconds for "Change of Bowel Habit" to 74 minutes for "Ulcerative Colitis". The mean interview length was 12 minutes. The program amounted to 575 megabytes of memory and the broadband download time (over a 2 megabyte broadband connection) was approximately 45 seconds for a 12 minute interview.

In testing, the auto run feature of the CD appeared to be robust and the opening screen for both the CD and internet versions is shown in figure 3.1. Observing this screen, only the gastroenterology button is active and a click through provides near instant access to the topic screen (figure 3.2).

Unlike traditional textbooks which are divided on the basis of symptoms or diseases, the *AnswersIn* module adopts a hybrid approach. The reasoning is that some subjects are better explained by taking a "decision tree" analysis (e.g. dysphagia) whilst others are sufficiently well circumscribed to be dealt with on their own (e.g. artificial nutrition).

Fig3.1- *AnswersIn* homepage

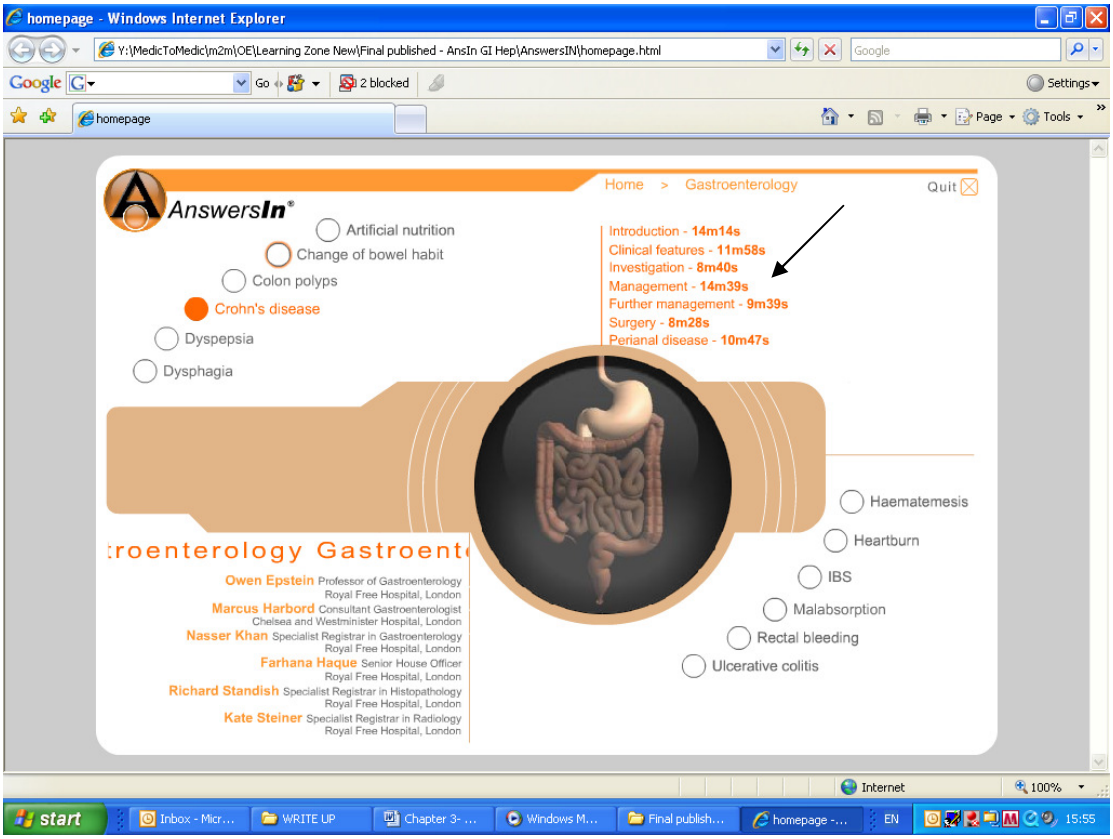

Fig 3.2- Gastroenterology menu page

Rolling the mouse over a subject displays the title and duration of each component of the subject (see arrow figure 3.2). Clicking one of the 12 options hyperlinks to the chosen screen page (as depicted in figure 3.3). Crohn's disease exemplifies the user interface.

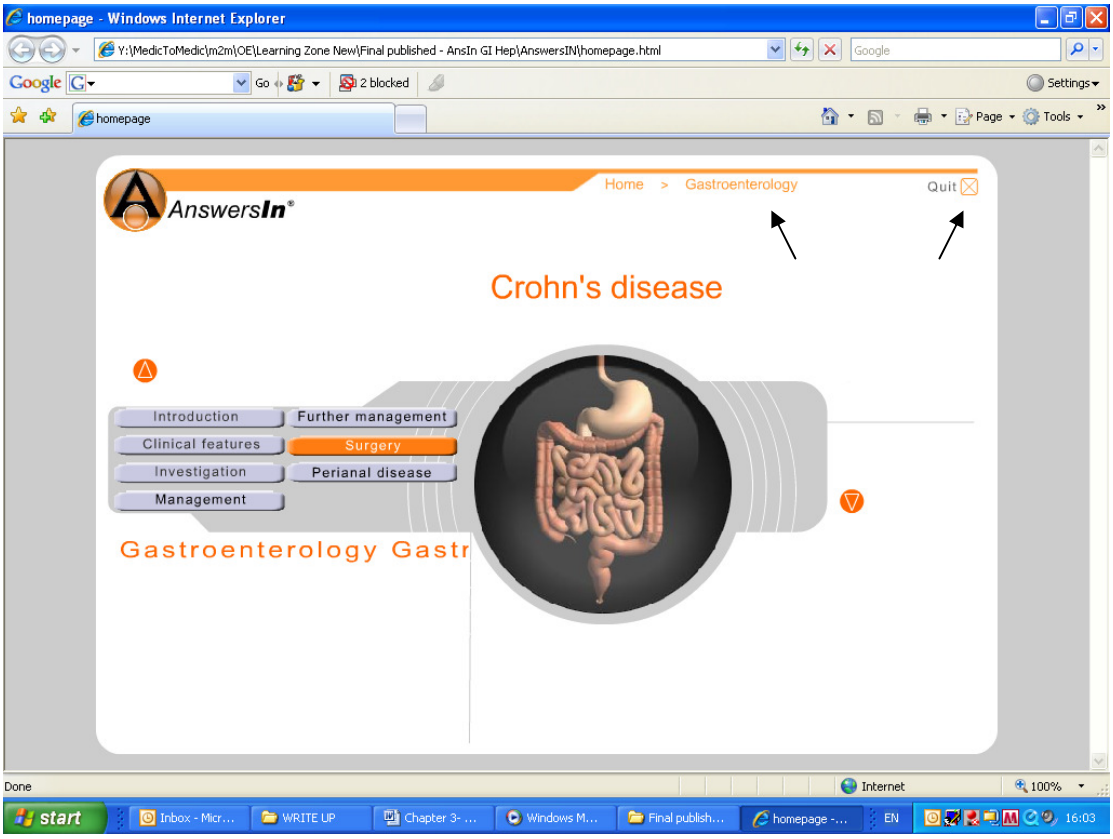

Fig 3.3- Crohn's menu page

The arrows in figure 3.3 indicate that navigation is aided by a "breadcrumb" line, informing the user of their place in the program and a "quit" button allows the program to be closed. From this screen, the user can directly access the interview; the following example illustrates the interview on surgery for Crohn's disease (figure 3.4).

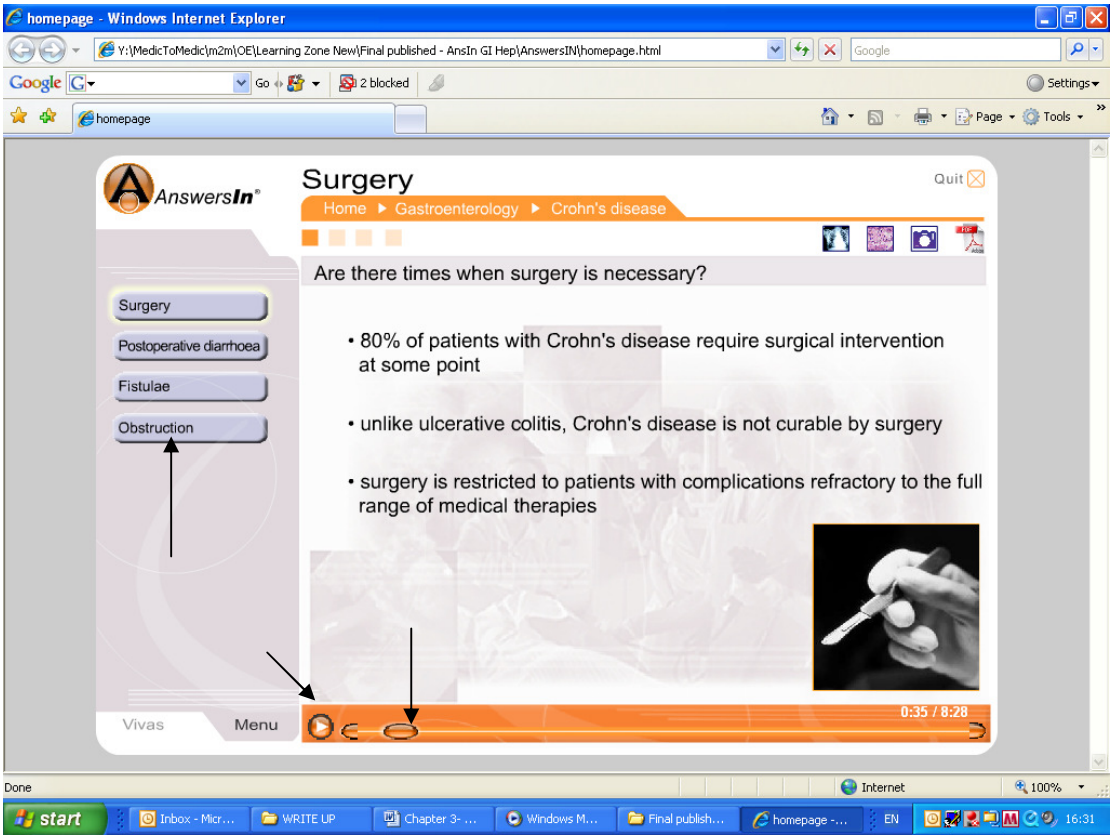

Fig 3.4- Main user interface

Figure 3.4 illustrates the main interface for the interview. The user is presented with a central display area which projects the bullet point text and pictures which appear in synchrony with the audio track. A panel along the left hand side of the screen further subdivides the topic, allowing the user to skip to any transition point in the interview (arrow). A timeline is present along the bottom of the screen (arrow) and this can be manually adjusted by the user to scroll to any point in the interview. The timeline also includes a standard video-recorder style icon for “play” and “pause” (arrow) providing the user with close control over the presentation. Where appropriate, simple animated sequences are introduced to support the audio track. An example is shown in figures 3.5-3.7 which supports the audio description of small bowel strictureplasty, a concept difficult to visualise from the audio alone.

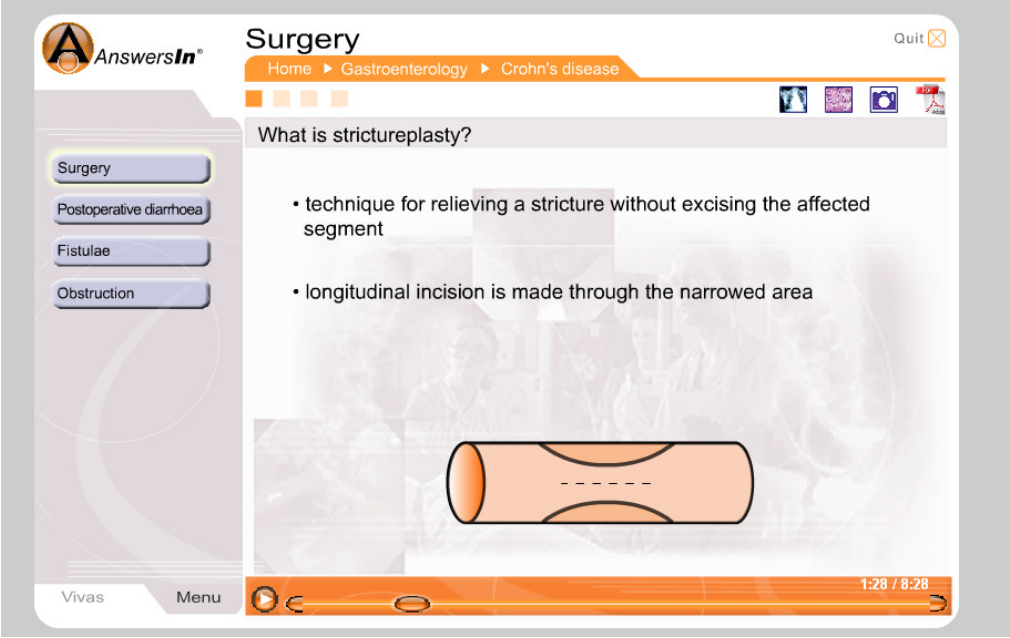

Fig 3.5- Strictureplasty animation 1

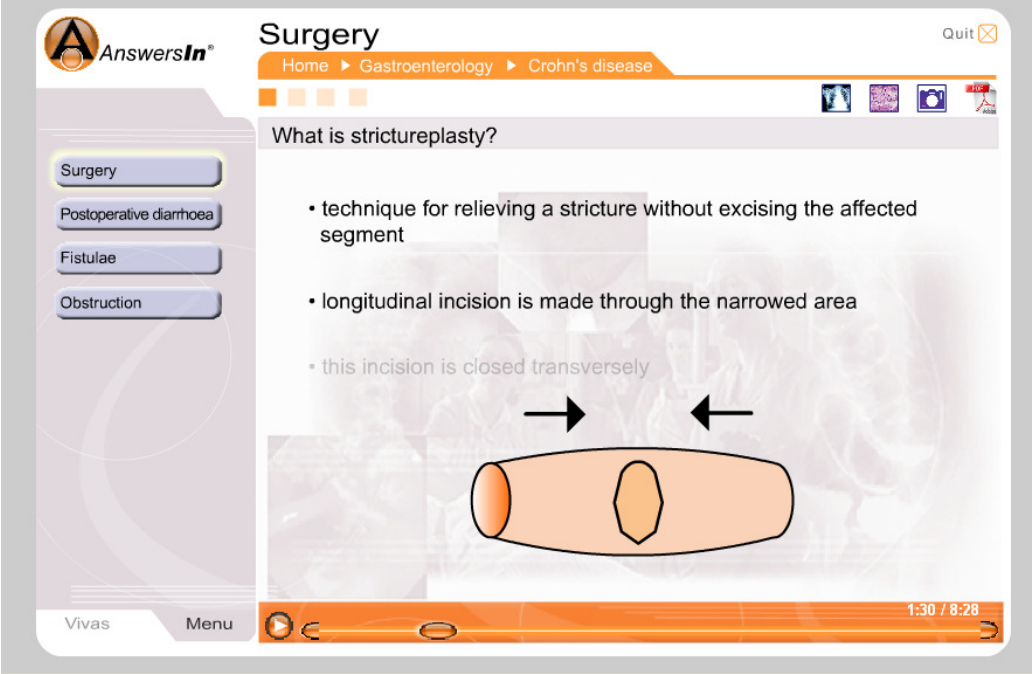

Fig 3.6- Strictureplasty animation 2

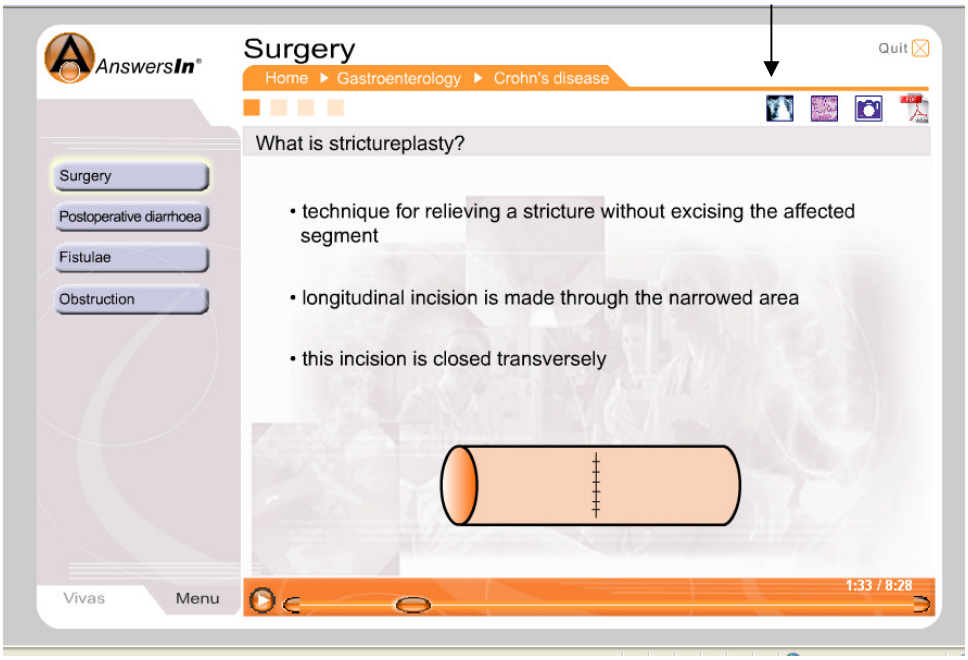

Fig 3.7- Strictureplasty animation 3

Clicking on the radiology icon in the top right hand area (arrow figure 3.7) provides access to a radiology gallery which displays a selection of radiological images pertinent to the subject of Crohn's disease (fig 3.8.)

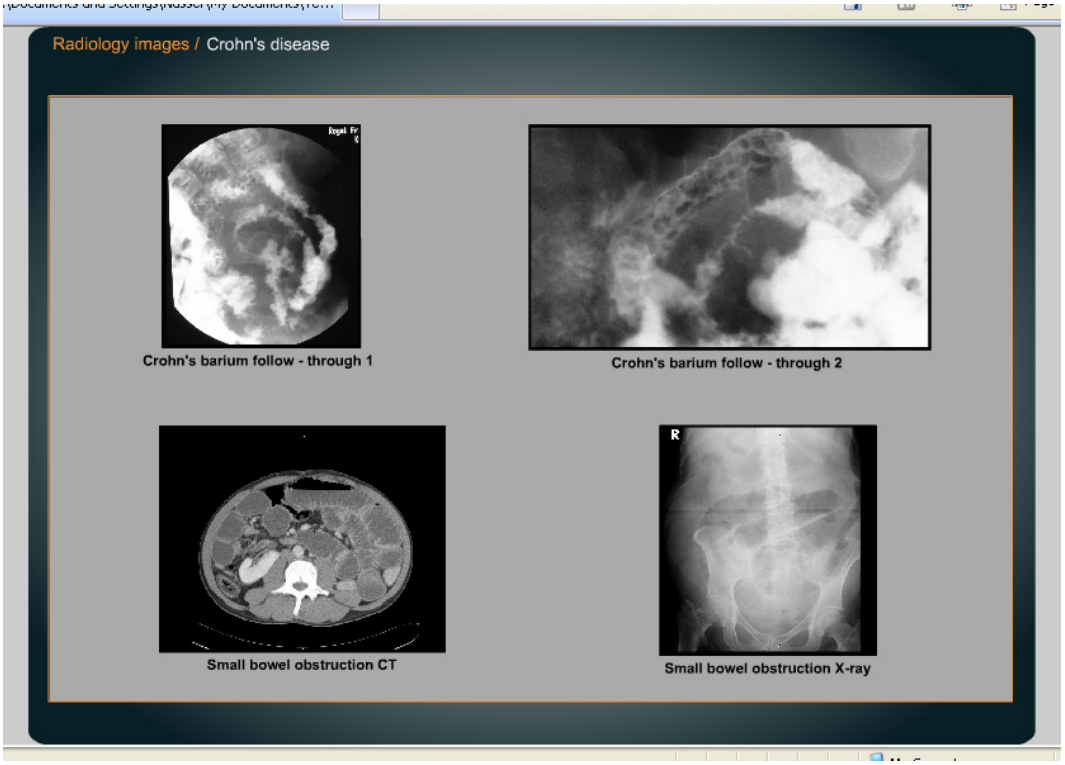

Fig 3.8- Crohn's radiology gallery

From this screen it is possible to select a thumbnail image which expands to a larger high-resolution image. The example in Fig 3.9 below is a computed tomography (CT) scan of a patient with small bowel obstruction due to Crohn's disease.

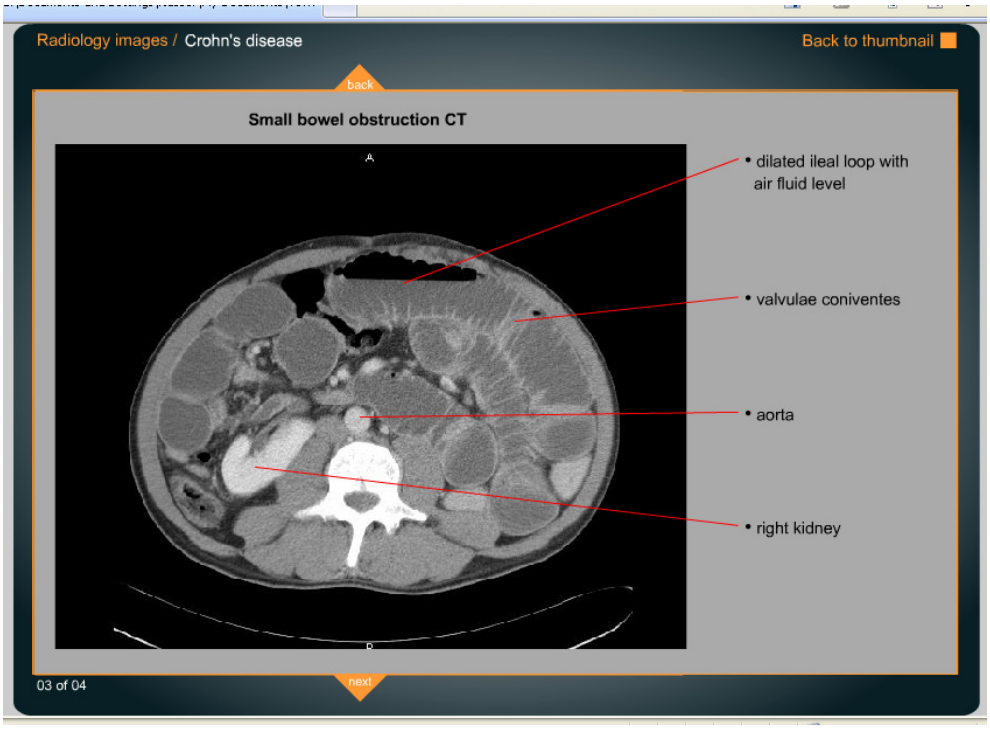

Fig 3.9- CT of Crohn's small bowel obstruction

Figure 3.9 displays an image which is labelled with arrows indicating salient features to the user. The annotated images can be scrolled through and the galleries provide the user with a resource beyond the core audiovisual presentation.

Pressing the adjacent histopathology button placed along the top of the main screen reveals a similar thumbnail gallery related to pathological features characteristic of Crohn's disease. Selecting one of the thumbnails provides access to high resolution digital images of pathology slides with labels and annotations which are appropriate to the level of the user. The example in figure 3.10 demonstrates a granuloma which is of a feature typical of Crohn's disease:

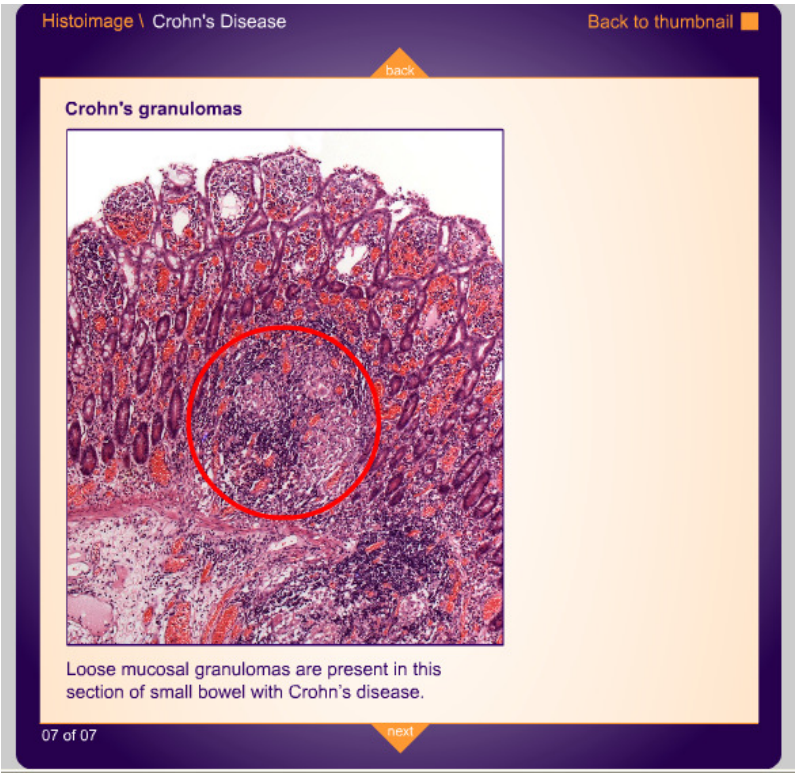

Fig 3.10- Histology slide demonstrating a Crohn's granuloma

An adjacent button (camera icon) in the toolbar allows access to an image gallery providing clinical and endoscopic images of Crohn's disease. (figures 3.11 & 3.12).

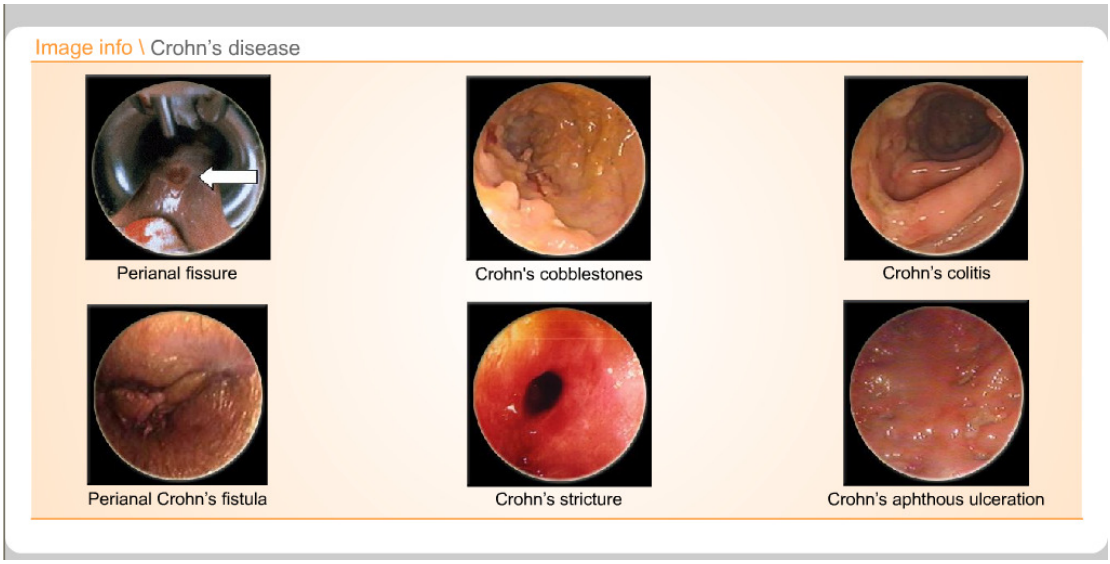

Fig 3.11- Crohn's gallery thumbnails

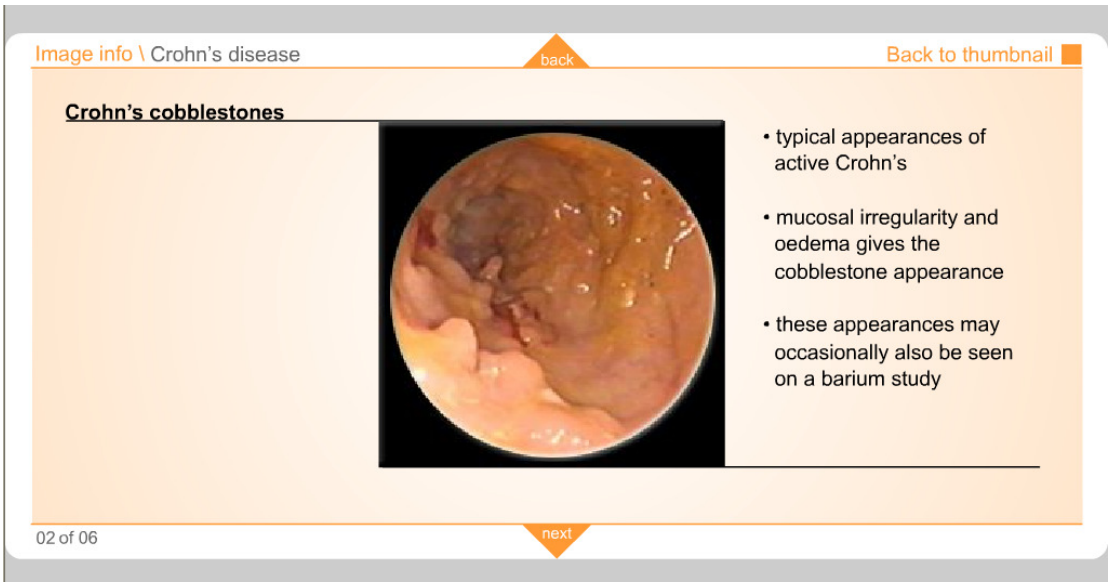

Fig 3.12- Gallery image of Crohn's cobblestones

A final icon allows access to a complete PDF© version of all the questions and answers within the interview (in bullet format). This allows the user to retrieve the core information in text form and represents an example of the potential for presenting content in a range of formats and offering students resources to fit their personal learning style.

Finally, the user has the option to informally test themselves using the "virtual viva" facility available on the left hand side (arrow) of the main screen (figure 3.13)

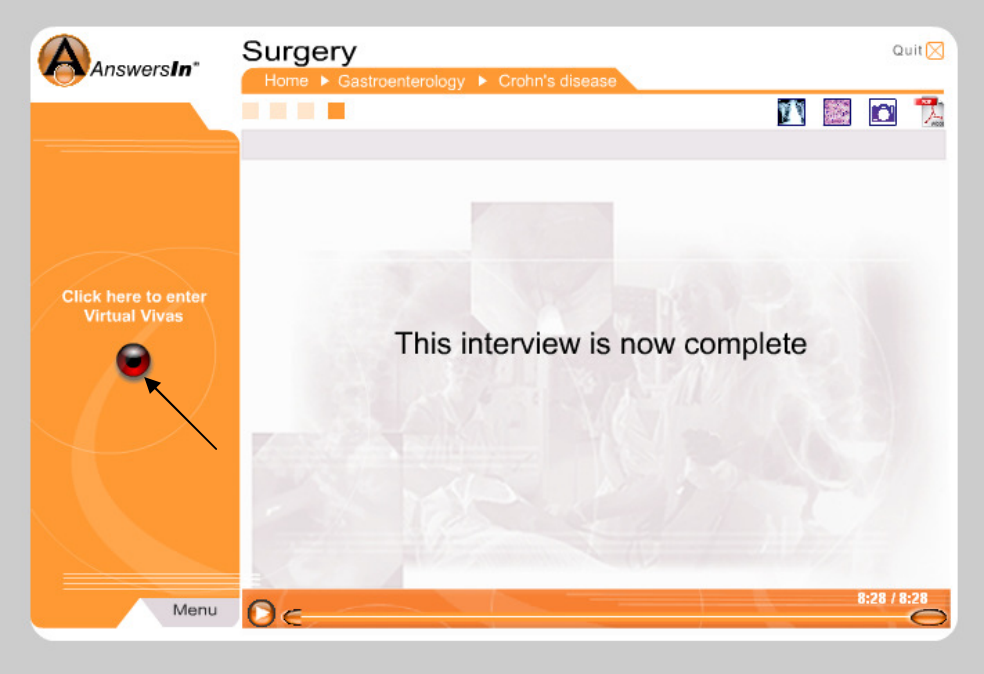

Fig 3.13- Invitation to access Virtual Vivas

From this panel, the user is presented with a sequence of questions which, if answered correctly, suggests that that the user has retained core information presented in the body of the interview. The correct answer is available when requested (figures 3.14 & 3.15)

Figure 3.14- Virtual Viva question

Figure 3.15- Virtual Viva Answer

Using the navigation system provided from the home screen, the breadcrumbs and the left hand panel, it is possible for the user to access all the topics in gastroenterology with a maximum of three mouse clicks.

To address the issue of feedback and the need for students to ask further questions arising from use of *AnswersIn* Gastroenterology, a Web Log, or "Blog", was developed. Students were informed about the Blog, invited to use it and the Blog site was checked daily by the development team and answers posted as appropriate (figure 3.16). Using a Blog was considered preferable to an email helpdesk as the responses posted would be visible to all users obviating the need to reproduce individual answers to the most commonly asked questions.

Fig 3.16- The *AnswersIn* online Web Log

The FLASH based *AnswersIn* module can be delivered on any mass memory storage device but for the purposes of evaluation, the application was initially recorded on CD-ROM and subsequently distributed via the UCL Intranet server with password controlled access given to GHEDNOH students.

Discussion

Developing the content for *AnswersIn* Gastroenterology and the content integration is akin to film-making. The process requires script writing, storyboarding, time in a recording studio, props (images) and a period of content integration, editing and distribution. The problems encountered in developing this CAL application were similar those typically encountered by the producer of a play or film.

Difficulties Encountered

Financial

Creation of a multimedia platform and content integration is not cheap. Expenses (see Appendix C) included:

- The salaries of the team members.
- Costs of outsourcing some IT work.
- Computing equipment (PCs, printers, software, consumables.)
- Studio recording time.
- Cost of using copyrighted images.
- Travel expenses.

- Had the subject being dealt with (gastroenterology) been outside the realm of expertise of the development team (OE is Professor of gastroenterology and NK is a specialist registrar in gastroenterology) then significant remuneration would have been required for other suitably qualified professionals to plan the core syllabus, script, edit and record the interviews as well as sourcing additional visual material. Indeed, this was the (pragmatic) main stimulus to provide a CAL module in gastroenterology

The development costs outlined above were met via research grants and support from UCL Biomedica (now known as UCL Business) which provides proof of concept funding for new projects generated within UCL.

A detailed breakdown of the costs of developing *AnswersIn* Gastroenterology is shown in Appendix C.

Scripting

Scripting a dialogue is more like writing a play than a review. The authors (OE and NK) had to develop new authoring skills for what was intended to be an engaging reverse-role dialogue, where the student asked the teacher the questions that teachers normally ask their students. Whilst the questions were easily constructed, the answers required considerable thought to ensure that the discourse maintained the form and pace of an interview rather than a lecture. Care had to be taken to ensure that each interview was detailed but readily digestible and segmented to allow for easy listening.

Recording

Co-ordinating the interviewer, interviewee, availability of recording studio time and travel time to the sound studio was problematic.

Rehearsals were difficult to timetable and most recordings were made with individual read-throughs prior to the session. Because the audio recording is easily edited, mistakes occurring during the recording sessions could be easily corrected with a retake of the sentence or paragraph and the errors deleted in post production editing. Coughs, paper rustling and other extraneous noises could also be removed in the editing process.

Bulleting & Storyboarding

Converting the flowing audio script of the dialogue into the bullet-point format required for the visual display and audio synchronisation introduced a further time-consuming step in the editorial process.

Animations were rough-drafted by NK and FF then developed the computer generated graphic sequences. Whilst animation is a powerful medium for illustrating certain concepts, the production process is complex and adds further cost and time to the project.

Gallery Images

Most of the endoscopic and clinical images were owned by OE but where missing images had to be sourced from elsewhere, copyright permissions had to be obtained. Often, a fee for use was levied, again adding to the expense of the production process. Radiological and histological images, and their annotation, required the assistance of a radiologist and pathologist. This added a further logistic problem as the completion of each section was dependent on finding the appropriate images, digitising and annotating the images, editing the media and then integrating the content into the program.

Integration, Editing and Proof-reading

Integrating the audio and visuals into the user interface was the most time consuming element of the production schedule. Approximately six to eight work days were required to create half an hour of audio synchronisation with the appearance of each bullet point on the user's screens. The integration of diagrams, pictures and animations required additional work-time. The slow development process constantly threatened the production schedule and with it, the ultimate aim of testing the application amongst third year medical students passing through their gastroenterology teaching block.

The skilled content integrator (FF) had no background in medical terminology and consequently most of the productions required considerable editing to correct spellings and grammatical errors occurring in the transcription process. With every proof read of each new iteration of the application, small content and software errors were discovered.

Despite aiming for a 2500 word limit to each segment of interview, the audio frequently overran the 20 minute limit. This required further editorial intervention with further splitting of the interview.

Locating and backing up the large number of digital files requires for each stage of the production presented a further logistic difficulty. This necessitated the creation of a coherent filing system whereby within a given subject, e.g. Crohn's. There was a uniform collection of folders which yielded the same type of files e.g. audio files, scripts, bullets and storyboards (figure 3.17):

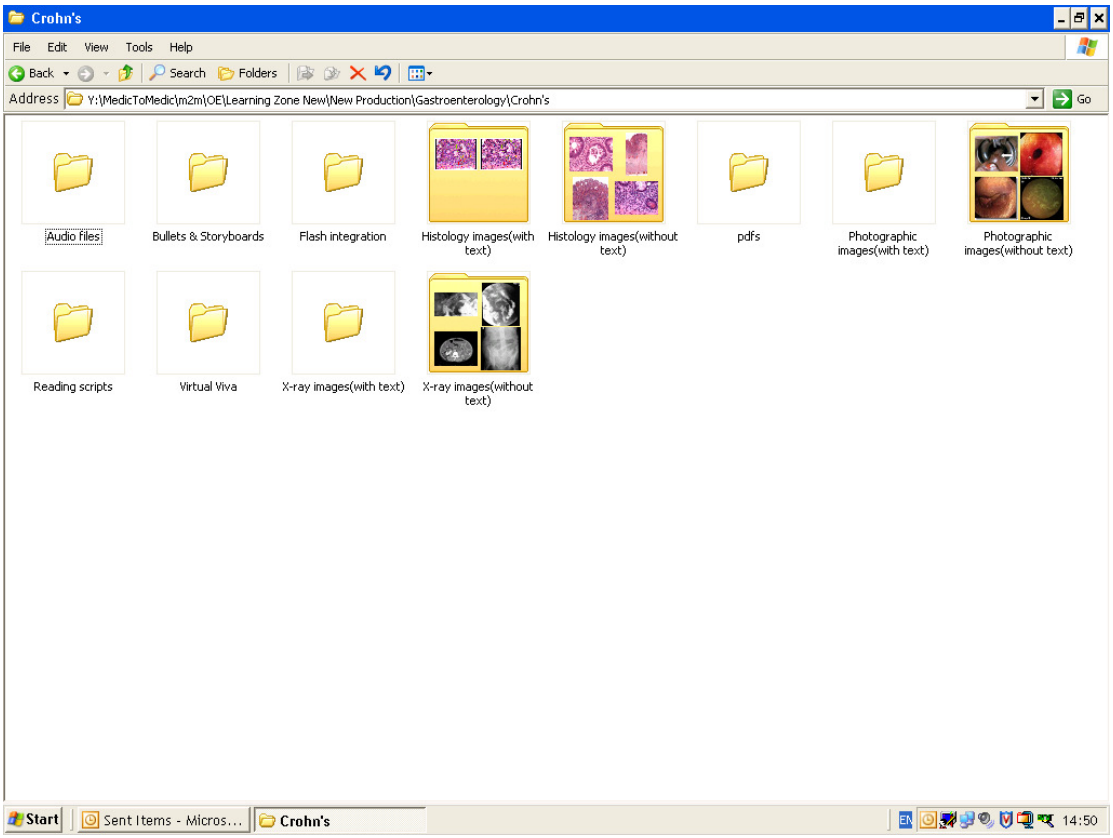

Fig.3.17- File structure for the components of Crohn's disease

Dissemination

The entire eight hours of FLASH multimedia consumed less than 600 megabytes of memory and consequently, it was possible to save the entire production onto a single CD-ROM. Whilst this is a convenient distribution medium, reproduction and packaging is a further expense and for this reason it was decided to restrict CD-ROM distribution to support the focus group assessment (Chapter 4) and to rely on the UCL Intranet for more widespread distribution.

The UCL IT department agreed to host a password protected version of *AnswersIn* for online access. However, considerable difficulty was encountered in adapting the module from CD to online delivery. Failure of the CD version to convert to the browser version was eventually shown to be due to different protocols governing the file extensions. Whilst running the program from CD did not depend on case sensitive file extensions, the server protocol required rigorous usage of lower case file extensions. Once this technical complication was discovered, all the file extensions had to be renamed resulting in a 5 week delay in placing the module online for use by the target group of medical students.

In terms of timescales, the overall project spanned 2 years with the first year allocated to analysis, design and development. The second (academic) year was given over to implementation and simultaneous evaluation. As previously mentioned, technical difficulties in placing the module on the intranet resulted in a 5 week delay but otherwise the project ran to time.

Maintenance and Sustainability

AnswersIn , once placed on the intranet, requires no technical maintenance as the Flash platform is inherently reliable and stable.

Maintenance of the clinical content is similarly minimal as the interviews were deliberately scripted to contain broad concepts and not "current management" topics which would be susceptible to any significant degree of obsolescence. That said, any future major paradigm shifts in our knowledge about the aetiology or management of a particular medical condition could be remedied in two possible simple ways:

1. Attachment of an addendum to the end of the presentations with added audio and bullet points representing "breaking news". This could be supplemented by an expanded PDF attachment.
2. Re-recording of audio transcripts at minimal expense and addition of relevant bullet point slides into the presentation.

Author's contribution to project

As well as sole authorship of this thesis, NK made the following specific contributions to the design and development of *AnswersIn*:

1. Scripting and proofreading of scripts (in conjunction with OE) including choice of topics
2. Organization of recording schedule for all scripts
3. Liaison with interviewees
4. Recording of some scripts

5. Bulleting and storyboarding of all scripts

6. Design of all animations (and direction of FF in this area when converting to Flash)

7. Coordination of schedule for Flash integration

8. Sourcing of all digitized images and video sequences

9. Sourcing of histology and radiology images (and liaison with pathologists/radiologists)

10. Proofreading of all finished content (in conjunction with TR)

11. Liaison with IT department

Conclusions

What emerges from this account is that the development of a bespoke multimedia program which meets many of the criteria for best practice in adult CAL is a daunting task.

The end result, however, fulfils the aims of the study. *AnswersIn* is a CAL module that provides a comprehensive audiovisual learning experience in gastroenterology utilising a novel interview style of teaching. The program can be accessed anytime and anywhere and the end user has complete control over the pace of learning via a simple interface. Interactivity is catered for via an internet based Web Log.

The main driver for the creation of *AnswersIn* has been OE and his enthusiasm for creating a learning tool which addresses the learning needs of the modern medical student faced with, on one hand, potentially overwhelming volumes of information from the internet and on the other, a possible reduction in the supply of face to face

clinical teaching. It is this enthusiasm coupled with a willingness to devote considerable research funds towards the project that has produced any tangible results.

The financial support required for such a project is considerable, not least the amount required to employ a research fellow (NK) who could devote their full energies to the development process. It is unlikely that such funding could be found from within the budget of a typical university department and would be hard to justify given the pressure to publish scientific papers and generally satisfy the requirements of the Research Assessment Exercise (RAE).

One source of funding may be from the commercial sector e.g. pharmaceutical companies but such ventures are seldom "free money" and risk questions being raised about the impartiality of the developer even if a conflict of interest genuinely does not exist.

Another revenue stream may arise from the licensing of the product to other medical schools although the names and faces associated with the speciality in question may not be familiar to other institutions and so the product may have a little less credibility. The "not invented here" phenomenon[264] may also be a strong factor affecting uptake in other institutions.

Perhaps the ideal situation would be for the institution as a whole to recognise the need to develop and nurture such projects on a larger scale and fund them appropriately.

Funding security is just the beginning. The organisational difficulties involved in creating a sophisticated CAL tool are significant. In the case of *AnswersIn*, a dedicated, if small, team was already in place but otherwise would have to be assembled. Again, if such initiatives were to be adopted on a larger, institutional, scale then perhaps a permanent team of employees could be retained expressly for the purpose of developing CAL applications.

Learning medicine involves the assimilation of specialist knowledge and, very importantly, in a directed fashion (compare this with the vast but un-vetted resources available on the World Wide Web). This means the computer programmer will be useless without the authorship and guiding hand of a medical professional appropriate to the speciality resource being developed. The *AnswersIn* experience suggests that the involvement of the medical professional is significant and mandatory at all levels of development. Clearly, this cannot be something that the medical professional can help create in a reasonable timeframe and still give priority to clinical duties.

AnswersIn was developed by gastroenterologists interested in the electronic teaching of gastroenterology. It remains to be seen if professionals in other disciplines will be as enthusiastic about giving up their time (remunerated or otherwise) in the pursuit of a CAL resource in their preferred speciality. On the face of it, such an undertaking would be in their interests but this does not necessarily translate into firm action.

The need for an editor (TR) is also noteworthy. In order for a module such as *AnswersIn* to have credibility, it must conform to certain standards of grammatical

correctness, syntax and spelling. It cannot be assumed that these standards will be adhered to by either the software programmer or healthcare professional. A possible second role for the editor is also as a project manager and this was indeed vital to the timely completion of *AnswersIn*.

Finally, and perhaps most crucially, *AnswersIn* (like so many other projects) was developed in isolation. The student response to *AnswersIn* is the major theme of this thesis but the institutional response to it will be harder to quantify. This is potentially worrying because, as discussed in chapter 2, a major factor in the success or failure of a CAL intervention is its integration within the formal curriculum. *AnswersIn* was not developed under the auspices of a curriculum committee and as such is not designed as a direct replacement for another teaching modality. Rather it is an "added value" tool which needs to prove its worth as part of a blended learning curriculum.

Whether the approval or opprobrium of medical students is material to the deliberations of a curriculum committee is not entirely clear at the time of writing.

Chapter 4- Evaluating *AnswersIn* Using a Focus Group Based Pilot Study

Introduction

Chapter 2 reviewed the various methods researchers have used in order to evaluate CAL applications. Most of these studies employed questionnaires and surveys which were then analysed using a variety of qualitative and quantitative methods. An observation made when reviewing this literature is the failure of these studies to report prior exposure of the application to the scrutiny of the target audience. This would seem to be an important step in developing a new application.

When observing matters from a *formative* evaluation viewpoint it can be seen that chapters 1,2 dealt with *needs assessments* (who needs the program, how great the need is, and what might work to meet the need) and chapter 3, to a significant degree dealt with *process evaluation* (the process of delivering the program or technology). With chapters 4 and 5, the aim will be to address *evaluability assessment* i.e. whether an evaluation is feasible and how stakeholders can help shape its usefulness.[265]

During the development of commercial software and computer games, it is common practice to recruit members of the target audience, expose them to the application and then document their responses by way of a recorded interview or focus group[266]. Using this method, software developers gain valuable insights into functionality and ease of use, patterns of use and potential changes that might be required to meet the expectations of the target population prior to release.

There are a number of methods used for beta-testing and evaluating new software applications. The most commonly used method is to provide individuals with the

software, allow them time for evaluation, and then ask for feedback using a questionnaire or a recorded one-to-one interview.

This technique, based on a compilation of single user responses does not provide the opportunity to generate new and unexpected insights that might evolve as a result of interaction between two or more interviewees. This is the key strength of using a focus group, a technique which is widely used in the qualitative market research field[267] [268] [269] [270].

A focus group distinguishes itself from other group interview formats. Specifically, other group interview formats rely upon the interaction between the interviewer and participants and the interviewer is able to influence the direction of the discussion while the interviewee has a somewhat more passive role[271]. In contrast, the focus group methodology is designed to encourage interaction between participants rather than discussion with the interviewer. In a focus group, the interviewer acts as a facilitator who provides a series of themes for the participants to discuss and focus on without attempting to influence the flow of discussion amongst participants.[272]. The interactions between the participants offers the potential for new insights to emerge that might not have developed in the more structured interview.

In general, focus groups are useful for[273]:

- Orientation to a particular field or focus.
- Developing themes for subsequent interviews or questionnaires.
- Generating hypotheses that derive from the insights of the group.
- Gathering feedback from previous studies.

Ideally, there should be more than one focus group for a given topic and it is recommended that size of each group should be limited to between four and twelve participants[274]. Additionally the group should have" homogeneity of background" in the area of interest.[275]

Aims

To use focus group and questionnaire responses of medical students to evaluate *AnswersIn* with a view to:

- **Formatively** evaluating and improving the structure and content of the program.
- Exploring attitudes to *AnswersIn* and its perceived place in the 3rd year undergraduate curriculum.

Materials & methods

In his phase of the study, two focus groups were assembled. The "market testing" comprised a paper-based questionnaire completed by each focus group member and a verbatim transcript of the recorded discussion that occurred in each of the focus groups.

The Questionnaire

The questionnaire was constructed to broadly address the themes to be used in the focus group. In addition, the questionnaire enquired about demographics and computer literacy. Each response was framed to facilitate a quantitative response (e.g.

five point Likert scales or YES/NO responses). Where appropriate, questions were framed to allow some free text responses (see appendix D).

Facilitator themes for the focus group discussion

The focus group facilitator briefly introduced the topic by stating the objectives of the *AnswersIn* application and explaining the concept of Socratic learning. A number of generalised themes were agreed as the basis for the focus group discussion (Appendix E).

These themes represented three key areas:

- Technical functionality and usability of *AnswersIn.*
- User responses to the content.
- User views on the place of *AnswersIn* within the current curriculum.

Recruitment & conduct of focus group

Participants were recruited from a group of thirty third year medical students who had recently embarked upon the GHEDNOH (General Medical Specialties) teaching module. After appropriate permissions were obtained, this group of students was approached by a blanket email invitation and the distribution of an identical flyer at a tutorial (Appendix F).

Volunteers who agreed to participate all completed a consent form before commencing the CD-ROM evaluation period (Appendix G).

An internet Web log which could be accessed by the participants was set up, checked daily and any queries or problems were dealt with within 24 hours. A second email address was also supplied to provide further back-up and support. The participants were asked to use the *AnswersIn* application wherever and whenever they deemed it convenient.

Two weeks after the distribution of the CDs, each focus group was held in a pre-booked tutorial room. In line with usual focus group practice, an experienced but independent facilitator (Ms Carol Parker, Academic Centre for Medical Education, UCL), who was unconnected with the project or the Hampstead Campus, agreed to conduct each of the two focus groups. Refreshments were provided and each focus group lasted approximately forty minutes.

After completing the written questionnaires, the participants were asked to choose an "alias". This assured the students anonymity when the recording was transcribed. Each student received a name badge allowing the facilitator and participants to address each other using aliases rather than real names for identification. An audio cassette recorder was used to record the entire interview and a back-up recording was made.

At the end of the focus groups the audio was retrieved and transcribed verbatim after which the audio tapes and back-up recordings were all erased. In line with usual focus group methodology, the typed verbatim typescripts were analysed for emergent themes and this provided the basis for the focus group evaluation.

Results

The focus group was advertised to 30 third year students participating in the GHEDNOH block. A total of eight students agreed to participate and all eight completed the study.

Questionnaire

All eight students completed the questionnaires and the results are shown in Table 4.1

Question 1: ***How useful did you find the following sessions compared to how you normally learn gastroenterology?*** *1(is not useful) to 5 (is very useful)*

Scale 1-5	***1***	***2***	***3***	***4***	***5***
Histology Section			**3**	**3**	**2**
Image Gallery Section				**2**	**6**
Radiology Section			**2**	**3**	**3**
The "Radio-Interview" style of AnswersIn		**2**		**3**	**3**

Table 4.1- Likert scale responses to question 1

The responses to questions 2-6 with selected free text responses are shown in Table 4.2:

Question	Responded YES	Responded NO	Relevant free text
2. ***Did AnswersIn work on your computer?***	**8**	**0**	**N/A**
3. Do you see AnswersIn replacing formal seminars/lectures?	**5**	**3**	1. Yes it may replace lectures but not seminars 2. Can replace some clinical lectures 3. Need seminars to consolidate knowledge 4. Prefer to learn in the comfort of my own home 5. cannot totally replace but may reduce number of lectures
4. Was AnswersIn easy to navigate?	**8**	**0**	1. Very user friendly 2. Everything was fairly obvious 3. Clear & simple interface 4. I liked the option to "skip" to a given point
5. ***Would you like to see other subjects covered using the AnswersIn format?***	**8**	**0**	1. All topics please! 2. Cardiology- useful for heart sounds 3. Pharmacology 4. All medical topics
6. ***Would you use AnswersIn as your main resource on a given topic?***	**5**	**3**	1. Yes if it was a topic I knew little about 2. Yes. much better than a textbook 3. Would use it as an overview but would still rely on books 4. Would use books as they are more detailed 5. Yes, it would complement the face-to-face teaching

Table 4.2- Yes/No & free text responses to questions 2-6

Question 7 - ***How do you think AnswersIn could be changed to better meet your needs?***

There was a range of free text responses represented below:

- "Would be useful to have topic summaries in printable PDF form but otherwise no changes needed".
- "More pathology with more detailed explanations."
- "Virtual Vivas could be more tailored to the relevant subsection rather than repeating."
- "Links to other useful websites."
- "A PDA version."
- "A glossary of terms would be helpful."
- "More differential diagnoses."
- "All bullets should come up at the same time rather than line by line as this will allow you to learn effectively without audio."
- "Examples of case studies please."

Question 8: **H*ow old are you?*** All eight respondents were aged 22 years

Question 9:***What is your gender?*** Four men and four women

Question 10: ***List any formal IT experience/qualifications e.g ECDL***.

Only two respondents answered item 10. Of these one had an IT GCSE (General Certificate of Secondary Education) and the other had an IT GCSE as well as an ECDL (European Computer Driving Licence) certificate.

Focus Group Transcripts

Analysis of the verbatim transcripts from the 2 focus groups revealed five dominant themes. These are outlined in table 4.3:

Theme	**Selected responses representative of the emergent themes**
1. Functionality of *AnswersIn*	1. I thought it was very easy to use. It looks nice, not too hard to get used to 2. The topics are clearly set out and then the sub topics are also clearly set out. 3. It is all very obvious 4. I quite liked using it, found it very natural and easy. 5. What is weird is that the topics are arranged in alphabetical order. I would arrange it so that something like ulcerative colitis would be next to Crohn's as they are related 6. It was quite user friendly, quite simple, easy to navigate. 7. The fact you put a disc in, start it up was not a long drawn out process, it was simple 8. The icons should be made a bit bigger or maybe spread them out a bit more. 9. I had been looking for a "back" button and there wasn't one, so maybe that could be added
2. *AnswersIn* and perceived learning needs	1. I thought the pitch was fine 2. I feel we get taught a lot of clinical medicine separate from pathology and then we have to go and learn pathology after that but I would find it helpful if they threw in a bit of pathology. 3. I don't see it in terms of replacing a lecture but it is nice to have a change from the old fashioned teaching 4. I would still like some lectures or seminars. 5. I would still read a book to get the information I want and then I would use *AnswersIn* as my revision 6. I would probably have it in the background in my bedroom and listen to it to help consolidate what I have learned 7. I would use it to try and keep myself on top of things 8. I cannot see it replacing books 9. I think it would be a good supplement to what we have got already and will enable certain other areas to be trimmed, for example, not having as many lecturers or seminars
3. Personal learning style	1. It was good as it is always about voice presentation. One is doing the same thing but more interesting 2. I remember more if it is explained to me why you get the signs and symptoms of certain diseases 3. I find them better than sitting at a lecture 4. I think *AnswersIn* is better then just reading a book as when you are reading a book it is so easy after reading a certain amount of text to just switch off. *AnswersIn* would hold my attention more. 5. Some topics like nutrition for example, to read would be extremely boring so I would prefer to listen to somebody as it is not something I need to know in massive detail 6. More relaxing than a book. 7. You do pick things up even if you are not 100% concentrating. If I had it I would put it on in the background sometimes 8. When it comes to revision I normally have the computer on and learn that way.

	9. I have never learnt very well when it comes to sitting and memorising books. I need to write it down. I have to read and write and read and write and learn again and again otherwise I cannot absorb the information 10. It is like memorising songs without you realising you are doing it.
4. User confidence/trust in *AnswersIn*	1. Professor ***** would always say "it is always important to consider the history" ….. Dr ***** will always say "well I am glad you asked that question". These are nice personal things as we know them so it makes it easier/familiar 2. For me, I would like to know the personality when they are talking 3. There is part of me that feels uncomfortable in taking all my information from a computer resource 4. It is important to me….the fact that he has written a book 5. I would be more worried about using a computer as to whether it is good information whereas in a text book I know that the information is correct. Whereas if you have someone like Professor ***** I feel safe to accept that this is good information 6. I do like the old fashioned style, the lecture and text book but if there were assurances on the computer of what you need to know then you would not have to spend hours going through books. This would make me feel more confident. 7. I do not think it was much him "being" Professor ****, more that he was good at it, whether it is because he is a consultant, I don't know 8. I don't think it really matters whether they are consultant or registrar, the level does not matter as long as they are good 9. I felt that when I saw Professor ****'s name and Dr *****s name, I thought wow, I am really going to listen to this because I had heard them before and knew who they were 10. If you have been taught by them before and like their teaching style, then you are more prepared to listen and enjoy the talk. 11. You know he knows what he is talking about whereas an actor would be different, not so convincing.
5. Perception of peer knowledge/access to teaching	1. The trouble with lectures this year is that there is such a range and there is a range over three sites 2. In clinical years it seems unfair if you know that one site is getting loads of good lectures and one site is getting the lectures cancelled or if they are happening, they are really bad 3. It is important that when you are designing something like this to know that the year is different throughout. 4. Certain people within the year will know facts that you would never dream of knowing automatically. You have to cater for everyone's base line 5. You set the base line where it is acceptable for a medical student in our year should know that so you don't need explaining of certain terms 6. One person might know a fact at the beginning of the year but another might only realise that the day before the exams. 7. Another group will tell you what they have been taught and we think "hold on, we were never taught that, we were told we did not need to know that." 8. It covers topics like malabsorption which is quite a obscure topic that not everyone knows about as opposed to the common ones that everyone knows about like ulcerative colitis

Table 4.3- Focus group emergent themes

Web Log

The Web log was used only once in the two week period by a single student who reported a broken laptop but still managed to access *AnswersIn* on another computer. No other problems were reported by the participants using either the Web log or the email help address.

Discussion

The two groups fulfilled the criteria recommended for focus group evaluation. There were four students in each group, with equal sex and age distribution and homogeneity of interest.

Questionnaire

The questionnaire indicated that six of the eight students evaluated the interview style of *AnswersIn* either useful or very useful whilst two students did not find it very useful.

All respondents found the image gallery either useful or very useful with more enthusiasm for the radiology gallery than for the histology gallery. All eight students reported that *AnswersIn* was technically robust, worked on their chosen computer and all eight found the application easy to navigate probably explains the lack of interaction through the Web log.

In the questionnaire responses, most of the students favoured *AnswersIn* as a replacement for lectures/seminars and a similar majority indicated that they would use *AnswersIn* as their main learning resource (as opposed to lectures or textbooks).

All the respondents indicated that they would like the *AnswersIn* format to be used to cover other curricular topics beyond gastroenterology.

There was a variety of suggestions on how *AnswersIn* might be improved. Suggestions included the addition of hyperlinks to useful websites and the provision of a *printable Portable Document Format (PDF) for each interview*. Participants recommended expanding the scope and scale of the virtual vivas and a change from the sequential appearance of bullet points in synchrony with the narration to a single screen download to reflect each themed audio sequence.

A pan-European survey conducted in 2001[276] suggests that students with formal IT experience are more likely to respond positively to CAL resources. It is of interest that whilst only two of eight participants had any formal qualifications in IT, all eight favoured the idea of a more extensive *AnswersIn* curriculum and five of eight favoured this form of delivery as an alternative to traditional lectures and would consider this as a primary topic based learning resource.

Focus Group

Review of the focus group transcripts indicated that the interaction between the respondents was a rich source of insights and served to modify views held within the group.

One example among many was the assertion by one respondent that he could not understand "why the audio had to be a conversation between two people" as opposed to just "one person talking". Another participant interjected that this would make the audio experience "just another lecture" whilst the to and fro between the two "recording artists" made the discussion "more stimulating". The first respondent then concurred and responded that "maybe that is why I like this better".

Another example arose from a discussion about how *AnswersIn* might fit in with the current curriculum. One interviewee said "I agree that it should be about choice as currently we do not have a choice in the way we learn. In this way there would be some lectures/seminars that people can attend, there would be *AnswersIn* if they wanted to use it and also people can still go to the library at the same time. I would like a mixture of all three". In response to this a second interviewee said "But then you cannot have lectures where people do not turn up". The first interviewee then replied "Lectures could be set up whereby you get the learning from the CD and books and ask questions at the lectures". In this fashion, a consensus was reached through group interaction.

The first theme to emerge from the focus group was that the *AnswersIn* module was straightforward to use in the CD disc format and no access problems were identified. Although not a formal a heuristic evaluation, the feedback indicated that the application as designed did not present any barriers to access by the users.

There was considerable overlap between the themes of perceived learning needs and learning styles. Although a number of participants indicated in the questionnaire that they could consider *AnswersIn* as a replacement for lectures or seminars, a different consensus emerged from the focus group.

In the focus group setting, the majority of participants considered that the application offered an additional and interesting resource rather than an alternative to lectures and seminars. There was recognition that *AnswersIn* could reduce the need for lectures but the groups' consensus was that there should be a framework for more personalised contact with the teacher in conjunction with greater use of *AnswersIn*. This is in contrast to questionnaire item 3 (*Do you see AnswersIn replacing formal lectures/seminars?*) to which five out of eight respondents replied yes. Closer examination of the written free text responses, however, seems to support the focus group findings.

This point further illustrates the inability of YES/NO questionnaires to accurately gauge opinion in the way that can be done using a focus group. Alternatively, this discrepancy may simply reflect the fact that questionnaires are at their most effective when there are a large number of respondents.

When discussing the presentation style, the participants expressed a general view that the audio was the most engaging and beneficial component. A number of participants added that they enjoyed listening to the audio in the background and there was a sense that information was still absorbed in this setting. This is clearly of interest

given the increasing attention being paid to the utility of audio *podcasts* in the provision of teaching.[277]

A further theme to emerge related to the personalities who contributed to and recorded the interviews. One participant did not place particular emphasis on the status of the interviewee and stressed the primacy of a satisfactory presentation style. The remainder, however, gave importance to the "provenance" of *AnswersIn* and recognition that the script was composed by, and recorded by, someone who was perceived by them to be eminent in their field. There was also comment that in general, textbooks, and lecture notes prepared by the teacher, carried a degree of credibility which could not always be ascribed to computer based resources. This suggests that CAL applications from unfamiliar sources may encounter credibility problems with medical students who seem to require assurances that the source is reliable, in line with their local curriculum and relevant to examinations.

The final major theme to emerge was concern that there were inequalities in access to various forms of modular teaching provided for groups within the same campus and especially between different campuses. There was broad consensus that *AnswersIn* could provide equality of access to learning resources within a modular multi-campus curriculum.

Limitations of the focus group evaluation

Ideally, a representative focus group should ensure a balance of views across the spectrum of attitudes and opinions. This focus group, like many others used in market research, was conducted amongst a group of volunteers and the attitudes and

opinions are likely to reflect the motivation to volunteer. Some might have engaged because of an interest in IT and technological innovation whilst others might have been motivated by an interest in gaining access to a further learning resource or learning style. Conversely, students who did not volunteer might have been less receptive to the general concept of CAL and failure to engage the less interested students might have contaminated the general conclusions drawn from the group.

The time limit to the duration of the focus group restricted the participants' scope for further exploring the role of *AnswersIn*. Whilst the questionnaire indicated that a majority of students considered the resource as a possible alternative to lectures and seminars, a different balance emerged in the focus group. Time constraints prevented deeper discussion around this conflict of attitudes and future focus groups might be restricted to one or two themes, including a discourse on the balance and nature of "on demand" learning and timetabled learning resources.

Additionally, not all the ten agreed sub-topics for discussion agreed before the focus group (Appendix E) were discussed by either group as to rigidly do so risked disrupting the "flow" of the discussion and thus a degree of licence had to be exercised by the facilitator whose main objective was to cover the three key theme areas.

Along with many other types of qualitative research, a well recognised problem with focus groups is the issue of observer influence. Any results obtained are influenced by the researcher, thus casting doubt on validity. Heisenberg, in explaining his Uncertainty Principle, was famously quoted as saying "What we observe is not nature

itself, but nature exposed to our method of questioning." As a result, the design of the focus group study including respondent recruitment, construction of questions and the manner in which the questions are asked has a direct effect upon the responses given by the participants.

Alterations applied to *AnswersIn* as a result of the focus group responses

As a result of the focus group, changes were made to both the questionnaire and to the *AnswersIn* program.

Questionnaire

Questionnaire item 3 (*Do you see AnswersIn replacing lectures/seminars on the same subject?*). This question failed to differentiate between lectures and seminars which are different group learning experiences. It was felt likely that students might rate these learning experiences differently, and the subsequent version of the questionnaire divided the question in two, asking the same question separately about lectures and then seminars.

AnswersIn program

As a result of the focus group feedback the following changes were made to the *AnswersIn* program:

- Each interview had an icon added which gave access to a printable PDF of the interview bullet points.
- In the follow on hepatology module which was developed to follow *AnswersIn* Gastroenterology, the sequential screen appearance of individual bullet points synchronised to audio was replaced by the simultaneous

appearance of bullet points. This is demonstrated in the *AnswersIn* Hepatology CD enclosed with this thesis (back cover).

- The subsequent hepatology module virtual vivas were written to reflect the content of the section under discussion (e.g. "Investigation of dyspepsia") rather than the complete topic (e.g. "Dyspepsia").
- In response to the positive views expressed by the focus group on the value of the audio alone, *AnswersIn* is currently being developed as an audio-podcast for delivery on an iPod or MP3 player.

Conclusions

Focus groups are an important resource for "market research" into a range of new initiatives ranging from politics to new consumer products. There is no reported use of focus groups in the development phase of CAL for medical students. This focus group provided the development team with an important interface between the creative phase of the *AnswersIn* application described in chapter 3 and the implementation phase described in chapters 6 and 7.

The focus group indicated that the interface and usability of *AnswersIn* was sound and in need of only minor adjustments . The participants expressed enthusiasm for the *AnswersIn* platform as a methodology for providing core content in gastroenterology, and wished to see the format extended to other subjects. In the focus group, but not the questionnaire, concern was expressed about the role of

AnswersIn as a direct replacement for lectures and seminars with the chief concern being the potential loss of face to face contact with the teacher.

In this context, *AnswersIn* was seen as a valuable add-on to currently available learning resources. The participants derived confidence from the fact that they were familiar with the "provenance" of the CAL resource and particularly the ability to link the information with a specific person. The focus group also identified concern about learning related inequalities that currently exist within their multi-campus medical school.

This focus group provided a valuable springboard for the progressive rollout of the *AnswersIn* program which is described in the chapters to follow.

Chapter 5- Medical Student Access to Multimedia Computer Equipment

Introduction

Over the last decade, the numbers of students gaining admission to medical school has steadily increased. The number of medical places has risen by over 2000, an increase of 40% in total intake[278]. This rise has been made possible by the establishment of new medical schools, and an increase in the number of students graduating from the established schools. However, increased student intake has not been matched by increased numbers of teaching staff[279] . This, together with rising costs of tertiary education, has conspired to force curriculum planners to look at new methods for delivering learning, and in particular, consider the role of multimedia and computer assisted learning (CAL) [280].

Most of the technologies used for delivering CAL, including desktop computers, web browsers and broadband Internet, have been enthusiastically adopted by the general public. In the UK, 57% percent of homes currently have a personal computer and 69% of these homes have broadband Internet access[281]. Broadband bandwidth can now support streaming video and the download of large multimedia files, offering the potential for remote access to audiovisual learning content. This has been matched by the development of multimedia authoring programs designed with sufficient simplicity, flexibility and depth for teachers to create content that is closely tailored to their students' needs[282].

There are other examples of the emergence of a new generation of mobile devices with potential to deliver learning content directly to medical students. These include personal digital assistants (PDAs), Apple iPods©, MP3 players and smartphones.

Podcasting is perhaps the most high-profile new medium where digital audiovisual or pure audio content is downloaded onto a docked iPod or MP3 recording device via an Internet connection. This form of knowledge dissemination has already been embraced by a number of institutes of higher learning in the United States and a number of the major universities have complete curricula offered in this format[283 284].

Any attempt to deliver a digital curriculum assumes that all students have equal access to the range of hardware devices that might be exploited for CAL. There is currently very little published data about the degree to which medical students use multimedia technology and no information on UK medical students' usage and access patterns.

Aim

The aim of this study was to ascertain to what extent medical students at a large UK medical school have access to a range of desktop and mobile devices which might be suitable for delivering multimedia CAL.

Methods

All Royal Free & University College medical students have a university email account. As this is the default medium for all student communication, most students access this email daily.

After gaining permission from the medical school authorities, a questionnaire (appendix H) was emailed to all third, fourth and fifth year medical students using Opinio[285], a web based survey tool. Almost all the responses were single word answers but the questionnaire included a free-text response to the question on access

to digital learning resources (see Q8& 9 Questionnaire). Two weeks after the original email, the same questionnaire was re-sent in order to maximise the response rate. To help ascertain whether or not the responders were representative, the identical questionnaire, modified for manual, rather than electronic completion, was distributed to 102 third year medical students attending an introductory lecture prior to commencing their clinical course at one of the three medical school campuses.

Results

The questionnaire was emailed to 1163 clinical students, and 349 (30 percent) responded to the first mailing. An additional 186 (16 percent) responded to the repeat email. In total, 535 (46 percent) of the student cohort responded to the email questionnaire. All 102 of the validation questionnaires were completed and returned for inclusion in the survey. The response to the questionnaire is summarised in table 5.1:

	Email responses (n=535)	**Validation responses (n=102)**
Response rate	*46%*	*100%*
1. How often do you use a personal computer?		
Every day	86%	88%
Every few days	11%	10%
Every week	1.5%	0%
Less frequently	0.5%	1%
2.Do you have access to a personal computer at home?*		
Yes	93%	97%
No	7%	3%
3. Do you have access to a personal computer at your place of work/study?		
Yes	87%	99%
No	13%	1%
4. Which of the following does your computer at home have?		
Sound card and speakers	85%	87%
The ability to listen with headphones	85%	91%
Broadband internet access	86%	92%
Dial-up internet access	19%	18%
A CD-ROM or DVD-ROM	96%	87%
Email	91%	84%
5. Which of the following does		

your computer at work/place of study have?		
Sound card and speakers	18%	47%
The ability to listen with headphones	45%	73%
Broadband internet access	91%	96%
Dial-up internet access	9%	6%
A CD-ROM or DVD-ROM	85%	91%
Email	96%	97%
6. If you have indicated that you have access to a personal computer at both home and work. At which location do you spend most time using a computer?		
At home	74%	75%
At work	10%	9%
Both approximately equally	16%	16%
7. Which of the following devices do you own, or have easy access to?		
MP3 player (any type)	63%	54%
Handheld PC/PDA	22%	12%
iPod	55%	56%
8. Which of the following have you used in your studies in past?		
Electronic learning resources	80%	78%
Interactive self-assessment tools	75%	73%
Virtual learning environments e.g. WebCT	77%	81%
Educational websites	81%	82%

Table 5.1- email and validation questionnaire responses

Over 90 percent of email respondents have access to a home computer and 87 percent had access from their place of work or study.

Eighty five percent of home computers were reported to have soundcards, speakers, whilst only 18 percent of the students reported access to audio from their study or workplace computers.

Eighty six percent of email respondents had home Broadband access and 96 percent of home computers had CD-ROM or DVD-ROM readers. Similar hardware specification was reported for computers available from their place of study or work.

Three quarters of the student respondents indicated that their home computer was their primary access point.

Over half the students have an iPod and/or an MP3 player and almost a quarter own a handheld personal digital assistant (PDA).

A range of responses was elicited by the last question (Q8) and a selection is shown in table 5.2.

LAPT-lite for medical students (LAPT is a certainty based assessment module)- 69 students
WebCT- 34 students
E-medicine.com- 9 students
BMJ Learning website- 8 students
www.fleshandbones.com- 8 students
PubMed- 6 students
www.google.com- 4 students

Table 5.2- Freetext responses to question 8 and their frequencies

Discussion

It is widely accepted that the formal class-based lecture format so prevalent for so long in tertiary education may not be the best way of conveying information[286] [287] Contemporary medical education now places considerable emphasis on self-directed learning (SDL)[288] . Indeed, the General Medical Council is explicit about the need to "*to encourage self-directed learning supported by informatics resources*."[289]

There are development and delivery problems inherent in switching from the traditional lecture format to SDL. Whilst lectures allowed students to aggregate to receive their teaching and learning, SDL demands that the knowledge is aggregated

and a mechanism is required for dissemination. CAL would seem to be a pragmatic methodology for both aggregating and disseminating learning materials and there is evidence that CAL offers an effective learning resource for medical students[290 291]. This, together with the targets set by the GMC and the disequilibrium of increased numbers of students and a relative fall in teaching faculty provides a powerful driver for the delivery of learning materials using CAL, Broadband Internet e-tutoring, e-notice boards, chat-lines, wikis and Blogs.

Whilst it is assumed that medical students all have access to multimedia PCs either in the university library or at home, there is currently no evidence-based information on what proportion of students have ready access to multimedia devices, how well they are specified and how many have access to the new generation of lightweight mobile media devices such as iPods©, PDAs and MP3 players, all of which could provide a gateway for delivering content.

This study at a large medical school addressed the question of student access to media players. The response rate to the twice-sent electronic questionnaire was 46 percent. This is comparable with the response rates of traditional postal questionnaires[292]. Failure to achieve higher response rates might reflect the observation that students often treat unsolicited email as junk email[293]. The validity of the sample was, however, in close accord with the identical control questionnaire, completed by hand, which had a 100 percent response rate.

The survey indicates that currently at UCL, the place of study or work provides inadequate access to computers specified to deliver multimedia. University and hospital libraries as well as general practice, where much teaching is delivered,

appear inadequately specified to deliver audio-rich multimedia. Computers in libraries are often aggregated in clusters and disabled for sound as it might interfere with activities of other students. In addition, there are local networks built around a "thin client" architecture which does not support audio. Whilst this observation has been made in a single multi-campus medical school, it is likely that similar constraints on audio specification occur more widely in medical schools across the country.

By contrast, access to appropriately specified home based computers is almost universal with over 90 percent of students indicating access to audio, CD-ROM and Broadband Internet. Shortcomings in the provision of campus-based multimedia hardware appear to be compensated for by the widespread availability of suitably specified equipment in the student's home, although up to seven percent of students do not have home access.

The availability of appropriate CAL enabled computers at home, and the observation that most students use computers at home in preference to their place of study or work, has implications for designing and timetabling CAL initiatives. Home, rather than university, might be positively identified as the prime location for delivering CAL. This could relieve hard-pressed library budgets of the need to build and constantly upgrade multimedia facilities and the timetable could facilitate the freedom of students to engage in CAL anywhere and at any time[294].

There remains the problem of providing all students with equal off-campus access as a small number of students did not have home access. Ensuring that all students have home access to Broadband Internet and a multimedia specified personal computer

would need to be addressed. Many higher education institutions in the US now stipulate the possession of a laptop computer as a mandatory requirement for 1st year undergraduates[295] and to achieve equality of access, ownership schemes would need to be developed in the UK. However, this solution would be costly.

An alternative approach might be to exploit the potential of relatively inexpensive mobile devices including PDAs, audio and video iPods , smartphones and MP3 players. Currently, just over half the respondents owned, or had use of an iPod, or other digital media player. Some US universities have already started delivering pre-recorded lectures to students using mobile devices[296], and iTunes U©[297] offers a portal for managing and delivering quite complex learning resources. As mobile multimedia devices become easier to use and cheaper to purchase, these media-players might offer an additional and inexpensive access point, freeing students from the desktop and notebook computer.

Conclusions

The 46 percent of students who responded to the e-questionnaire did not differ substantially in their responses to the control group of written respondents. If our sample is at all representative of most UK medical students (the composition of UCL medical students is certainly representative of the applicant pool)[298], the opportunity now exists to consider delivering e-learning directly to students in their preferred learning environment using a range of media devices ranging from Smartphones, iPods, MP3 players and PDAs to laptop and home-based desktop PCs. Content developed for the PC in FLASH can be readily converted to alternative formats without a complete rewrite. We have already successfully developed an adapted

AnswersIn prototype from the PC FLASH program which can be delivered on a video iPod.

Students take a more pragmatic approach to how they obtain their information compared to their peers 30 years ago[299] . This, together with the findings of this study on the availability of multimedia players to suit a variety of tastes and circumstances, suggests that this is an appropriate opportunity to exploit the development of on-demand CAL.

Although access to suitably specified computers in the home is likely to rise in the future, it is necessary to strike a note of caution when dealing with equality of access. Between 3 and 7 percent of students in our survey did not have access to a suitably specified home computer and this (probably diminishing) minority would need to be catered for by curriculum planners.

It seems that currently, in the home at least, the hardware and broadband Internet connections are currently in place to explore learning on demand, a goal recognised as highly desirable in medical education. Teachers and universities need to recognise the full educational potential of the technology infrastructure that is currently available to their students and against this background, act to meet realise this potential.

Chapter 6- Implementation of a web-based platform for the delivery of *AnswersIn* Gastroenterology and the student experience of this novel teaching program

Introduction

In the technologically developed world, medical students have access to an unprecedented volume of learning resources which would not have been available ten years ago, much of which is available on the internet or on CD-ROM . Examples of freely available internet resources include e-medicine[300] , Medscape[301], BMJ learning [302] while Up To Date[303] is a good example of a premium pay service. Other websites such as medicalstudent.com act as portals to useful sites[304]. Despite the widespread availability of a pot-pourri of web-based learning material, the students' focus group consensus revealed a preference for textbooks and lectures/seminars as their prime learning resource (Chapter 4). However, the focus group also indicated that the *AnswersIn* platform was a resource that would be valuable and worthy of further development.

The findings described in Chapter 5 indicate that the majority of medical students in the clinical years of study have access to suitably specified home-based multimedia computers linked to a broadband internet connection. This confirms that an infrastructure currently exists to distribute core learning material such as *AnswersIn* Gastroenterology, allowing access to audio-rich content beyond the campus network.

In the two week pilot study of *AnswersIn* Gastroenterology undertaken by participants of the focus group, the module was distributed on CD-ROM to ensure that all the users would have ease of access. Having established that over 90 percent of clinical students have home access to broadband internet at home and suitably specified multimedia computers, it seemed timely to deliver *AnswersIn* to a larger

cohort of medical students from a website. The web provides a highly efficient mechanism for distributing content and offers students a wider range of access opportunities than CD-ROM.

This chapter describes the process of transforming *AnswersIn* Gastroenterology from CD-ROM to a web based portal, tracks the logistics and problems encountered during this transition and describes the student experience as the resource was progressively rolled out from the Hampstead Campus to all three major RFUC campuses.

Aims

- To establish a web-presence for *AnswersIn* Gastroenterology on the RFUC medical school website
- To assess the technical and delivery issues encountered in developing a web-enabled *AnswersIn* resource to 3rd year medical students, initially at the Hampstead campus and then across all three medical campuses of the multi-campus medical school
- To examine the medical student experience of *AnswersIn* delivered from a web-server
- To determine student views as to the place *AnswersIn* might occupy in the current undergraduate medical curriculum

Methods

The study population

The group studied comprised of cohorts of third year clinical students engaged in the 10 week clinical gastroenterology module at the Hampstead, Bloomsbury and Archway campuses. Each campus is allocated between 25 and 35 students for the 10 week block which includes gastroenterology and other medical specialties. During the academic year September 2006 and September 2007, the block was repeated four times. The timetable was punctuated by vacation periods as well as a one week pathology block between each transition. These blocks were numbered one to four with block 1 commencing in October 2006 and block 4 ending in August 2007.

Procedure

The changes recommended in chapter 4 by the focus group students were implemented and the *AnswersIn* program was programmed for delivery via a broadband connection through the medical school intranet.

After testing the application on a development server to ensure that all components were functioning correctly, the final version of *AnswersIn* was implemented on the university server with access restricted by means of a password and username[305].

Prior to informing students of the availability of *AnswersIn* Gastroenterology on their campus, the gastroenterology tutors at each campus were provided with the intranet link to the program and were asked to review the material. Permission was then obtained from tutors at each of the three campuses to inform their student cohort by

email of the availability of *AnswersIn* Gastroenterology as an additional learning resource.

The deployment of *AnswersIn* was managed in a staged sequence. This is reflected by the classification described below which indicates which campus was involved and whether or not the block was associated with a summative examination.

- Hampstead campus phase 1 (HC1) – this refers to the first implementation to test whether the web-delivery platform and e-mail alert to students were robust, and that an end of block questionnaire could be completed with a high response rate. There was no summative examination held in this block.
- Hampstead campus phase 2 (examination block HC2e) – this phase examined student attitudes to *AnswersIn* provided from day one of the 10 week gastroenterology teaching block. All the students in this block undertook a scheduled summative written examination at the end of this block.
- Hampstead campus phase 3 (HC3) – this phase examined student attitudes to *AnswersIn* provided from day one of the 10 week gastroenterology teaching block. A summative written examination was not delivered at the end of this block.
- Multi-campus phase 4 (MC4e) - this phase examined student attitudes to *AnswersIn* provided from day 1 of the ten week gastroenterology teaching block. Students from all three campuses had access to *AnswersIn* Gastroenterology during this phase and at the end of this block, all students had a written examination.

Informing the medical students of the availability of *AnswersIn*

After obtaining permission from the RFUCMS Deanery, a group email (Appendix I) was sent to the designated student group t notifying them of the availability of the program and URL. The protocol stipulated that the email should be at the beginning of each of the 4 phases of rollout and contain the following information:

- The availability of the module and its website address (URL).
- Instructions on how to access *AnswersIn.*
- An indication that *AnswersIn* Gastroenterology was a requirement stipulated by their clinical tutors in gastroenterology.
- Availability of a Web log for technical support and feedback or queries.
- The availability of a CD-ROM version of *AnswersIn* for students who did not have access to broadband internet.
- Contact details of the study coordinator for general support.

Recipients of the email were asked to confirm receipt using the "received" notification function available on Microsoft Outlook©.

In the final week of each block, the study group was asked to fill in anonymised questionnaires which enquired about their experience of using *AnswersIn* Gastroenterology. For HC1 students this questionnaire was the same as that used in the pilot study (see chapter 4 and Appendix D). However, following analysis of the questionnaire delivered to the focus group, for subsequent phases, question 2 was rephrased. The original question "Do *you see AnswersIn replacing formal lectures/seminars? YES/NO"* was replaced by two questions enquiring separately

about *AnswersIn* Gastroenterology replacing lectures, and seminars. All the questionnaires were manually distributed and collected by a member of the medical school staff who was not identified as being connected with the *AnswersIn* project.

Questionnaire Analysis

After collection of the questionnaires, the quantitative data was tabulated using Microsoft Excel©, and SPSS 15© (Statistical Program for Social Sciences)[306] was used for statistical analysis. All free text responses were collected, aggregated according to phase and analysed for dominant themes.

Results

HC1 – Implementing *AnswersIn* on the Intranet

The initial plan was to ensure that *AnswersIn* Gastroenterology would be available on the RFUCMS intranet from the beginning of the HC1 block. By this point in the evolution of the project, the *AnswersIn* Gastroenterology module was fully functional and had been successfully delivered on CD ROM (chapter 4). The web administrator indicated that the program could be promptly implemented on a development server and when live testing was complete, could be immediately extended to full online access for the target students.

The transition from CD ROM-based delivery to broadband Internet was complicated by unforeseen technical problems:

When the module was first placed on the development server, the homepage appeared but the interactive navigation buttons were not visible. This transition fault was

eventually traced to a phenomenon whereby FLASH program components, when implemented online in a web environment, become case-sensitive. Consequently, any Flash document with upper case characters was not viewable using the Internet Explorer© interface. The entire application had to be reprogrammed to ensure that all the relevant files were reassigned in lower case. This unexpected bug delayed implementation and was only resolved when the HC1 students were already three weeks into their block.

A second attempt at implementing the module onto the development server exposed a further transition problem. Despite correction of the case sensitive files, some files, which functioned perfectly on the CD version, were still not accessible. In addition, the printable PDF files were not viewable. Further investigation indicated that additional reformatting of the CD ROM version was required and the problem with the PDF files was also traced to case sensitivity.

A further 2 week period of intensive restructuring was required to resolve these problems and on the third attempt, the *AnswersIn* Gastroenterology program was successfully implemented on the development server and was subsequently placed on the university server.

The unexpected implementation problems delayed implementation by five weeks and the HC1 block were already 5 weeks into their block before the application could be reliably delivered. No further transition problems were encountered during the follow on blocks.

The Questionnaire

A total of 178 students attended the four blocks of the study. Completed questionnaires were collected from 143 (80 percent) of students.

The response rates for the individual phases are illustrated in table 6.1. All the responses have been aggregated to provide an overview of how students responded.

Phase	Campus	Total students	Number responded	Response rate %	End of block exam?
HC1	Hampstead	32	29	90	No
HC2e	Hampstead	30	20	66	Yes
HC3	Hampstead	30	28	93	No
MC4e	Bloomsbury	27	23	85	Yes
MC4e	Archway	26	18	69	Yes
MC4e	Hampstead	33	25	75	Yes
Total		**178**	**143**	**80**	

Table 6.1 – Individual phase and total questionnaire response rates

The lowest response rate was seen in Phase HC2e and was due to an administrative error at the time of questionnaire collection.

The results outlined below follow the sequence of the questions as they were asked in the questionnaire. Response rates lower than the 143 respondents who completed the questionnaires, indicate incomplete responses for some questions.

Q1- How useful did you find the following components of the AnswersIn website?

The Likert scale responses assessed the usefulness of key components of *AnswersIn* Gastroenterology. These are summarised in table 6.2.

AnswersIn component	N	Minimum	Maximum	Mean	±Std. Deviation
Histology	103	1	5	**3.72**	.912
Image	105	2	5	**4.06**	.770
Radiology	105	1	5	**4.02**	.832
Interview	118	2	5	**4.38**	.750

Table 6.2- Range and means of Likert responses (1- not at all useful to 5- very useful)

Q2 .Did AnswersIn work on your computer?

One hundred percent of the respondents indicated that the program worked as expected on their computer.

Q3 .Did you use AnswersIn?

Of the 143 responders, 121 (85 percent) indicated that they had used the program. Of the 22 respondents (15 percent) who did **not** access *AnswersIn,* reasons cited included (see appendix J):

- Preference for books.
- Not "getting around to it".
- Examination stress.
- Unaware of the resource.

Q4. Do you see AnswersIn replacing Lectures/Seminars?(HC1 only)

Response	Respondents	Percent
Yes	11	**40.7**
No	16	**59.3**
Total	27	**100.0**

Table 6.3- HC1 Responses to Q4

Q4. *Do you see AnswersIn replacing lectures?* (HC2e, HC3, MC4e)

Response	Frequency	Percent
Yes	27	**28.7**
No	67	**71.3**
Total	94	**100.0**

Table 6.4- HC2e, HC3, MC4e responses to Q4

Q5. *Do you see AnswersIn replacing seminars?* (HC2e, HC3, MC4e)

Response	Frequency	Percent
Yes	8	**8.5**
No	86	**91.5**
Total	94	**100.0**

Table 6.5- HC2e, HC3, MC4e responses to Q5

The majority of students favoured the retention of the lecture and seminar format. When posed with the question of whether *AnswersIn* Gastroenterology might act as a substitute, more students favoured preservation of the seminar format than the lecture format.

Free text responses associated with Q4 and Q5.

The free text responses (Appendix K) that followed on from these questions revealed a number of reasons why students would oppose or favour *AnswersIn* providing a replacement for lectures and/or seminars.

There were students who favoured replacing traditional lectures and/or seminars with the *AnswersIn* platform. The reasons given fell into 3 broad groups:

- The ability to access *AnswersIn* at the learner's convenience.
- The ability to control the pace of learning.
- Comprehensive resource.

Of the students who did *not* favour replacing traditional lectures and/or seminars with the *AnswersIn* platform, the reasons given fell into 4 broad groups:

- Lack of interactivity and the ability to ask questions directly.
- Lack of contact with fellow students.
- Concern that loss of the discipline imposed by the lecture/seminar timetable might disadvantage students who learnt best when disciplined by an attendance register and formal learning structure.
- *AnswersIn* Gastroenterology considered a useful supplement to traditional lectures and seminars rather than replacement.

Q6 Was AnswersIn easy to navigate?

A total of 122 respondents (85 percent) answered this question and 100 percent of respondents stated that *AnswersIn* was easy to use.

The themes that emerged (Appendix K) included:

- User friendliness.
- Ease of finding the relevant topic.
- Clear instructions.
- Clear & intuitive interface.

Q7 Would you like to see other subjects besides gastroenterology being covered using the AnswersIn format?

A total of 121 respondents (84 percent) responded to this question .Of these, only one respondent replied "NO".

The free text responses (Appendix K) divided into two broad themes:

- Respondents who favoured coverage of all the major specialty areas.
- Respondents favouring coverage of specific topics. The most common requests were for endocrinology, nephrology, hepatology, radiology and histopathology.

Q8. Would you use AnswersIn as your main resource on a given topic?

Of a total of 121 respondents to this question (84 percent of total respondents), 40 (33 percent) stated that they would use *AnswersIn* as their main learning resource on a given subject whilst 81 (66 percent) indicated that they would not.

Of the students who stated that they *would* use *AnswersIn* as their main resource, the free text responses (Appendix K) fell into the following broad categories:

- Those respondents who indicated that *AnswersIn* was already their main learning resource.
- Those who expressed a positive response to the question with the proviso they could be assured that subsequent exams would be based on the content of *AnswersIn.*
- Those who expressed confidence in the thoroughness/ comprehensive nature of *AnswersIn.*

Of the students who stated that they would not use *AnswersIn* as their main resource, their reasons for not doing so fell into the following broad categories:

- Those who preferred textbooks.
- Those who preferred to see *AnswersIn* as an equally useful supplement to other resources.
- Those who found *AnswersIn* to be too slow to function as an effective revision aid.
- Those who considered textbooks more "trustworthy."
- Those whose learning style was not suited to computer based study.

Q9. How do you think AnswersIn could be changed to better meet your needs?

Fifty one students responded to this free text question. Their responses were broadly categorised into the following themes:

- Requests for more "exam style" questions.
- Requests for links to other web-based learning resources.
- Suggestions for coverage of other topics.
- Recommendations that other downloadable formats such as audio only MP3 should be available for listening on commonly available portable devices.
- Suggestions that *AnswersIn* required closer integration with the formal taught course in medicine.

Q 10& 11- How old are you and *What is your gender?*

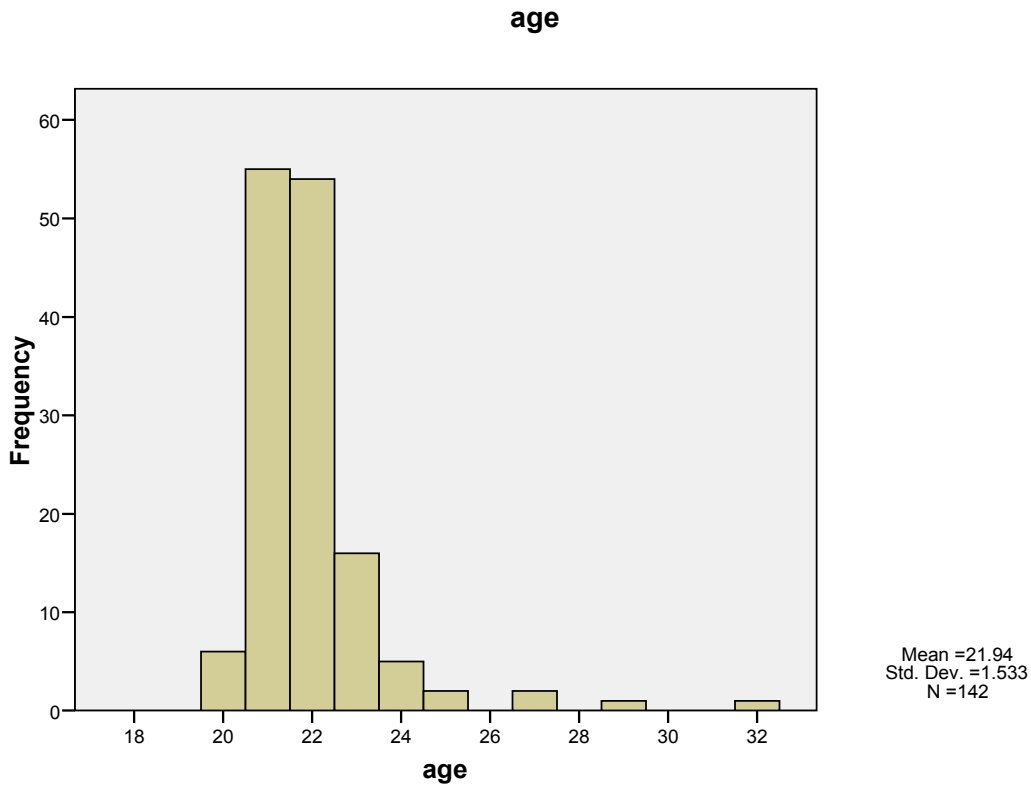

Fig. 6.1- Histogram representing age ranges of respondents

Figure 6.1 indicates that the majority of respondents were aged 21 and 22. Of the 143 respondents, 86 (60 percent) were female and 57 (40 percent) were male.

Q12. List any formal IT experience/ qualifications e.g. ECDL (European Computer Driving Licence)

Of all 143 respondents, 28 (20 percent) possessed some form of IT qualification and 115 (80 percent) had no formal IT qualification.

The types of IT qualification were the following:

- IT GCSE
- IT A-Level
- CLAIT©[307]
- Key Skills

There was no statistically significant correlation between age, gender, previous IT qualifications and mean Likert scores or other YES/NO responses There was also no statistically significant correlation between Likert scores, YES/NO responses and the campus at which the student was based.

The Web log

No submissions were posted on the Web log at any point during the four study phases.

Discussion

This chapter describes the transition from CD-based implementation pilot to a fully operational web-based resource distributed across a large 3 campus medical school.

The progressive rollout of *AnswersIn* was planned in four 10 week phases, each coordinated with a new cohort of medical students. Phase 1 (HC1) was used to deploy *AnswersIn* on the medical school intranet and this phase provided an opportunity to discover and solve implementation problems. Success in the first phase allowed the provision of *AnswersIn* Gastroenterology to cohorts HC2e and HC3, and once the web-based resource proved robust, the program was made available to all students across the 3 campuses (MC4e) during their gastroenterology block. In addition to informing on the implementation issues of delivering a web-based learning resource, attitudes to the program were explored by questionnaires delivered to 178 students who had access to the medical school website 143 of whom responded.

Implementation of the web-based platform to deliver *AnswersIn*

The aim to move rapidly from a CD to a web-based based application and deliver it to HC1 was delayed by a series of unanticipated practical and technical difficulties. This resulted in a 5 week delay in providing access to students in the HC1 block. When finally implemented, the *AnswersIn* application proved robust and trouble free.

The development of *AnswersIn* Gastroenterology was unencumbered by Medical School rules and regulations which might have stifled creativity and informal And close collaboration with the web administrators facilitated the rapid development and distribution of the CAL program. However, the development experience suggests that

Medical Schools wishing to encourage the development of web-based learning by their medical teachers should offer clear guidance on how to develop and implement a new electronic initiative.

CAL content developers require reliable technical support and a clearly defined link with a designated web server contact who, in turn, has a clear brief to encourage and support educational initiatives. Whilst this project indicates the potential for non-technical CAL developers to drive a web-based electronic learning platform, the development highlighted the level of technical expertise that needs to be available for content integration (e.g. FLASH programming) and web-related problem solving.

Verifying that students received the introductory email proved unreliable. It had been anticipated that the confirmation function offered by Outlook© would provide an assurance that all the students in the cohort had received the email. All the outgoing introductory emails were successfully relayed but only 10 percent were confirmed as read by the students. On further enquiry, it transpired that this facility was not enabled on some of the recipients' email programs, and probably accounted for a proportion of failed acknowledgements. In addition, discussion with students indicates that when given freedom to choose whether or not to respond, the latter choice is often made "to protect anonymity" and this might have further contributed to the unexpectedly low rate of acknowledgement[308].

The final chapter of this thesis (Chapter 8) has drawn on this experience of developing *AnswersIn* Gastroenterology to recommend a toolkit for Medical Schools to consider implementing to support CAL "entrepreneurs".

Questionnaire responses

The completion and return of end of block questionnaires presented difficulties. The structure of the GHEDNOH module differed at each of the 3 campuses and only the Hampstead campus had an identifiable coordinating physician. Consequently, it was difficult to organise an end of block meeting at the Bloomsbury and Archway campuses where all the gastroenterology students would be gathered to facilitate the completion and collection of the questionnaire.

Informal support, goodwill and cooperation from both consultants and medical school administration did, however, make it possible to deliver the questionnaire to medical students, with 80 percent responding. The 20 percent non-response was due to non-attendance at the end of block meeting and not due to failure to complete the questionnaire. This response rate contrasts with the response rate of 46 percent for the email questionnaire on access to multimedia reported in chapter 5. The high response rate was achieved because the questionnaires were personally distributed and collected and did not rely on email or a postal response.

Utility of *AnswersIn* pathology, histology and image galleries and topic interviews

Of the 4 components built into the module, the histology gallery received the lowest Likert rating. Although the mean score of 3.72 suggests more utility than not, the rating may reflect the lack of didactic pathology teaching in most modern medical curricula including RFUCMS. There is also some evidence that medical students no longer consider pathology central to their learning[309].

The radiology and image sections, as judged by the Likert rating, were deemed to be more useful. There is no formal radiology teaching in the RFUCMS curriculum. Unlike histopathology, most medical students expect that once qualified, they will be expected to interpret radiology plain films without recourse to a report[310]. This, together with the shortfall in formal radiology teaching, might explain the students' more positive response to the radiology gallery.

The highest mean Likert score (4.38) was for the "interview style" of *AnswersIn* Gastroenterology. This suggests that core premise behind the module, which was to deliver learning using an interview style, fulfilled its expectation of high value amongst the students.

Technical implementation of *AnswersIn*

All the respondents reported that *AnswersIn* Gastroenterology functioned without problems wherever and whenever they chose to log on. The robust operation of the application is reassuring as difficult access or technical failure is likely to undermine any attempt to deliver CAL on the Internet. The application only went live after extensive evaluation, and during the phase of "play testing" on a development server, a range of software bugs which were discovered and corrected prior to inviting student access.

Considerable planning was undertaken in the development phase and the bugs that emerged in the migration phase were unexpected and resulted in a 5 week delay in providing access to the first student block (HC1). This phase of the study indicates

that when setting an implementation timetable, it is necessary to build into the timeline a rigorous testing phase for the migration from desktop to web. By the time *AnswersIn* Gastroenterology was made available for student access, the application was technically sound and access through the medical school intranet was both fast and reliable.

Reasons for student non-participation

Of the 15 percent of students who indicated in the questionnaire that they had not used *AnswersIn* Gastroenterology, none cited access difficulties as a reason for not using the resource. There were a variety of reasons including busy schedule, not having heard of the module and expressed preference for books. However, from the free text responses arose a recurrent theme of examination stress and implicit within this was the lack of free time available to access *AnswersIn*.

In chapter 1, evidence was cited that adult learning is goal orientated. It is likely that the 15 percent who failed to use *AnswersIn* failed to connect the resource with their learning goals. In future, a clear and explicit link between *AnswersIn* and the examination curriculum might entice diffident students to explore *AnswersIn*. .

AnswersIn Gastroenterology as a replacement for lectures and/or seminars

In the first block (HC1) the questionnaire did not distinguish between lectures and seminars, and 59 percent did not consider *AnswersIn* Gastroenterology as a replacement for lectures or seminars. On reflection following the first block responses, this question was considered imprecise and failed to identify students' attitudes to lectures and seminars as two different learning experiences.

In HC2e, HC3 and MC4e, the question was separated into "lectures" and "seminars" respectively. In these blocks there was an emphatic response in favour of preserving lectures (71 percent) and seminars (91 percent). This raises the question of why students continue to favour the classroom lecture format despite evidence questioning its standing as a suitable learning environment in modern education[311] and the arguments made earlier in the thesis for good learning to take place in the student's preferred place and time. It is likely that the student affection for lectures is nurtured by familiarity with the medium and trust that lectures and seminars are likely to include the content most likely to arise in ward rounds, small group teaching and examinations.

A recurrent theme running through both sets of free text responses to these two questions was concern over the loss of interactivity with a "live" teacher especially in the more intimate seminar setting. This is consistent with evidence of student concern about the potential for CAL to erode the valued teacher-student relationship[312].

It is interesting that some students identified the timetabled lecture/seminar program as a helpful discipline for less motivated students who, left to their own devices in a CAL dominated learning environment, might otherwise have less incentive to discipline their learning.

Respondents who wished to preserve lectures and seminars still expressed great enthusiasm for *AnswersIn* Gastroenterology, but as a supplementary rather than primary learning resource. This observation supports evidence that students view

CAL as a means to "supplement rather than supplant" more traditional teaching techniques[313]

Those who responded that they would approve of *AnswersIn* Gastroenterology replacing traditional lectures and seminars cited the convenience of CAL and lack of enthusiasm for the traditional teaching formats as reasons. This group may represent a well defined subgroup of enthusiastic early adopters, technophiles, or learners who prefer sources other than formal lectures for the gaining of information[314]

Ease of use

All the respondents found *AnswersIn* easy to use and navigate. The cohort comprised students both with and without any formal IT qualifications and the ease of use across the group indicated that *AnswersIn* Gastroenterology fulfilled its design brief to provide an intuitive a web-based application without the need for tutorials or a training manual.

Attitudes to the use of the *AnswersIn* format to cover subjects other than gastroenterology

All but one respondent indicated a desire to see other medical subjects covered in a similar fashion. Most favoured a blanket curricular approach covering all subjects; others were more specific about topics they might prioritise. Topics singled out included endocrinology, nephrology, pathology, hepatology and radiology. This selective response may reflect a perception of inadequate teaching provision in these subjects rather than a fundamental topic related selectivity bias.

Use of *AnswersIn* as a main learning resource

33 percent of respondents stated that they would use *AnswersIn* Gastroenterology as their main topic-based learning resource. Some respondents, in the true spirit of "early adopters"[315] stated that it was already their main resource for gastroenterology. Others felt that a closer and more explicit association of *AnswersIn* Gastroenterology content with the formal curriculum and exams would be more likely to induce them to use the application as their main resource. This response suggests that an official and high profile endorsement of the learning suite by the medical school and its curriculum committee might provide the necessary guarantee so valued by the students and that this, in turn, might substantially influence attitudes to its primacy among other learning resources. In keeping with this, the 66 percent of respondents who did not consider the *AnswersIn* platform as their main learning resource mostly indicated that they placed greater confidence in recommended textbooks and lecture handouts as a primary learning resource with *AnswersIn* being viewed as a valuable but additional resource.

Other comments included dislike of learning from a computer screen and two respondents found the format of *AnswersIn* too slow for revision.

The schism between those favouring *AnswersIn* Gastroenterology as a primary learning resource and those who favoured traditional learning probably reflects personal preconceived ideas of best learning methods and longstanding learner familiarity built on years of traditional teaching focused on school and university examinations. New and fundamental innovations in teaching need to recognise that in the early phase there will be a minority of enthusiastic early adopters and a

majority of more sceptical and conservative learners who might require a more prolonged period of exposure and in particular, the reassurance of formal endorsement by the medical school.

There is, however, the possibility of a digression between attitudinal responses reflected in the questionnaire and on-line student activity and the latter is further explored in chapter 7.

Suggestions for improving *AnswersIn*

Question 9 offered the students the opportunity to recommend improvements to the *AnswersIn* format. A number of students requested the incorporation of exam style questions. This response is in keeping with the principles of goal-oriented andragogical learning. Bearing in mind the connection adult learners make between engagement in learning and goals, a closer association of *AnswersIn* with the taught course and end of block tests appears to be an important strategy for encouraging adoption.

There were also suggestions for creating a purely audio format for delivery on portable media players including MP3 players and iPods. This suggestion resonates with the high Likert rating for the interview style at the heart of *AnswersIn* Gastroenterology format. A highly portable approach would further free students to learn in their chosen time and place and would accord closely with the lifestyle attraction and widespread availability of these media players. As a result of this suggestion, an audio-only *AnswersIn* Gastroenterology module has been developed for use on portable devices.

Student demographics

Twenty percent of respondents indicated that they had an IT qualification. There was no correlation between any items within the questionnaire responses and possession of an IT qualification, campus, sex or age. The 3:2 female to male ratio accurately reflects the official data on gender ratios of medical school entrants[316].

Study Limitations

The main limitation that was encountered was the absence of a pre-validated questionnaire suitable for evaluating student responses to *AnswersIn*. An attempt was made to validate the questionnaire by discussing the content within the Medical Education department at UCL and then incorporating it into the pilot study (chapter 4). This allowed refinement of some items but the variety of free text responses obtained for certain items gave rise to the suspicion that some of the questions were somewhat ambiguous.

An example is the item requesting details of formal IT qualifications. In retrospect, the respondent may have been confused as to what constituted a formal IT qualification and perhaps an approved list from which to select an item would have been more revealing and provided a more accurate answer.

There is a conspicuous lack of published validated questionnaires specific to the evaluation of CAL interventions.

Another possible shortcoming pertains to the data collection method. Despite their low response rates, postal and email questionnaires can usually be assumed to have been completed by willing respondents. The weakness in this argument is that these questionnaires may subsequently be more likely to be completed by respondents with strong positive or negative feelings about the intervention in question with the ambivalent perhaps less likely to respond. By collecting questionnaires at close quarters, more representative samples may be obtained in theory but potentially depriving the respondents of the option not to participate may risk making them more hostile in their comments and thus less objective.

The absence of comments on the live Web log was striking and on one hand may reflect the absence of any difficulties in using the module but may also reflect the fact that the Web log was not integral to the program but rather a separate web page with a separate log-on process. As a result of this additional technical complication, potentially valuable "real time" insights and comments may have been lost.

Conclusions

AnswersIn Gastroenterology is technically robust and capable of delivering content reliably across a three campus medical school. The application fulfilled its other design specifications; students found the application easily accessible through the internet, the program was readily navigated and the intuitive user interface succeeded in avoiding a training step.

All components of the module were deemed to be either useful or very useful and there was a high degree of support for the novel presentation style which was central to the concept and design of the *AnswersIn* format.

Consistent with existing evidence on CAL[317 318 319] , most respondents did not regard *AnswersIn* Gastroenterology as a direct replacement for lectures or seminars but rather as a valuable supplement to currently available learning resources offered by the formal curricular structure.

Drawing the respondents' comments, there appears to be sufficient support for the medium to expand the *AnswersIn* series to include a wide range of specialties and topics. In addition, there appears to be considerable scope for migrating the audio component to portable media devices including MP3 players and iPods.

It seems clear that an expanded version of *AnswersIn* into the curriculum would be favourably viewed by 3rd year medical undergraduates but that uptake is likely to be incremental and heavily dependent on formal and informal endorsement by the medical school's deanery, curriculum committee and teachers. It seems likely that nurturing the application in this manner will lead to greater confidence in its role in the undergraduate learning environment and that in time, the potential of the *AnswersIn* format to offer high quality learning on demand could be realised.

Chapter 7- Monitoring the patterns of usage of *AnswersIn* by medical students and the effect of advertising

Introduction

Chapter 6 addressed some key questions related to the technical feasibility of delivering a password protected, on demand learning application on the university intranet, its operational robustness and accessibility to the students. All the hurdles were successfully negotiated and 85 percent of students visited the *AnswersIn* Gastroenterology website. All but one of these respondents (120 out of 121) stated that they would like further subjects to be covered using this format.

Whilst the accessibility, acceptability and utility of *AnswersIn* Gastroenterology is supported by these findings, it is not clear whether actual usage patterns reflect the positive responses obtained.

In the pilot study described in chapter four, where *AnswersIn* was distributed on CD-ROM discs, it was not possible to derive an objective measure of the real use of the learning resource.

One distinct benefit of placing a CAL resource on the internet is the ability of the server to collect data about usage patterns using web-tracking software which is able to monitor activity 24 hours a day, seven days a week. There have been studies evaluating the use of server statistics to document access volumes[320] and how frequency of usage correlates with exam performance[321] . Further studies confirm the importance of combining usage patterns with feedback surveys in order to validate CAL interventions[322]. Most studies have used web tracking to count the number of educational website "hits" or to count the total number of students or other healthcare

professionals accessing that site and identified by a passwords[323] [324] . There is however, little descriptive data pertaining to the range of statistics that can be obtained from web-tracking software.

Web monitoring also provides the opportunity to assess the effect of interventions on usage; for example how reminder avertising emails sent to students might impact on use.

Aims

The aims of this study were:

- To describe the usage statistics available on the server hosting the *AnswersIn* program
- To investigate the effect of direct email advertising on the use of *AnswersIn*

Methods

Study Population & Data Collection

The study population comprised Blocks 2, 3 and 4 (HC2e, HC3, MC4e respectively) of the same cohort of medical students described in chapter 6. The students in Block 1 (HC1) were not included in this study due to the unexpected technical difficulties encountered in making *AnswersI*n available for this group from the beginning of the clinical block.

The *AnswersIn* module was placed on a University Web Server as described earlier in chapter 6 and activity monitored using Webalizer©, a web log analysis software

tool[325]. The software is designed to interrogate the website and provides detailed numerical data on volumes and patterns of usage.

The software was interrogated to obtain the following information:

- Hits- The total number of requests made to the server during a given time period (month, day, hour etc.)
- Files- The total number of hits (requests) that actually result in the return of information to the user
- Pages- These are the URLs reflecting the actual page being requested, but not all of the individual component items such as graphics, videos and audio clips)
- Kilobytes (KB) downloaded - This is 1024 bytes and a measure of the amount of data transferred between the server and the remote machine, based on the data maintained in the server log.
- Sites- The number of unique IP addresses/hostnames that made requests to the server
- Visits- A visit is logged when a remote site makes a request ("hit") for a page on a server for the first time. As long as the same remote site continues requesting within a given timeout period, this will be considered part of the same visit

The Webalizer program allows the user to view temporal variations in all of the above parameters over hours, days, weeks and months.

Additional information included:

- Most popular *AnswersIn* pages visited
- Most popular *AnswersIn* pages which were downloaded from (interviews or PDFs)
- Most frequent/heaviest users of *AnswersIn* by email ID

Clinical Scenario Advertising using the "push" email

The initial email introducing students to *AnswersIn* and notifying them of the URL was sent at the beginning of each block as previously described (Appendix I).

After appropriate permissions were obtained from the medical school authorities, the GHEDNOH students were sent a group email at the midpoint of the 10 week block, , describing a clinical scenario relevant to the gastroenterology curriculum. The email indicated that the response to the clinical scenario could be readily accessed by activating a hyperlink embedded within the email with a single mouse-click; this would call up the appropriate content in the *AnswersIn* program. An example is given below:

Dear GHEDNOH Student

"You are sitting in clinic with a consultant gastroenterologist. The patient in front of him has been referred with dyspepsia and heartburn. The consultant turns to you and asks:

"What is the difference between dyspepsia and heartburn?"

What is the answer?

Find out the answer to this commonly asked question at:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Introduction to dyspepsia" interview for a full answer

The email was sent via Microsoft Outlook© along with a delivery confirmation request and a request for the recipient to confirm that they had read the email. The first email was sent on the Wednesday of week 4 of the 10 week block and weekly on the same day thereafter. A total of 6 emails, each describing different clinical scenarios were sent were sent to the same group of students (Appendix L). The email schedule and term dates are shown in Table 7.1.

Block	Beginning of block	1st Advertisement email	End of block
2 (HC2e)	18/12/2006	24/01/2007	09/03/2007
3 (HC3)	19/03/2007	25/04/2007	01/06/2007
4 (MC4e)	11/06/2007	11/07/2007	17/08/2007

Table 7.1- Official term dates and first email dates

The effect of advertising was not measured in Block 1 (HC1) as the *AnswersIn* module was not placed online until week five.

The effect of advertising *AnswersIn* was measured for an equal number of "term days" before and after the first advertising email (Table 7.2). Term days were defined as weekdays, weekends and bank holidays during term-time but excluding medical school holidays (specifically Christmas and Easter).

The pre/post exposure cut-off point was midday on the Wednesday that the first advertisement email was sent.

The number of counted exposure days in Block 2 was less than in Blocks 3 and 4. This was due to a protocol violation in Block 2 where the first advertisement email was sent a week early. This was compensated for by appropriately reducing the number of *post-exposure* days which counted towards the analysis. The final week of each block did not form part of the analysis as this week's activities was dominated by end of block examinations

Block	"Term days" counted from	1st Advertisement email	"Term days" counted to	"Term days" pre/post-1st advert	Holidays
2	18/12/2006	24/01/2007	14/02/2007	21.5/21.5	22/12/2006-7/1/07
3	19/03/2007	25/04/2007	25/05/2007	29.5/29.5	5-11/4/07
4	11/06/2007	11/07/2007	10/08/2007	30.5/30.5	N/A

Table 7.2- Dates for which usage data was recorded

The effect of advertising *AnswersIn* was measured in terms of "hits" on the website and volume of data downloaded before and after the first advertising push.

Questionnaire Component

At the end of the GHEDNOH student blocks 1-4, all students were asked to complete the questionnaire described in chapter 6 (Appendix D). For Blocks 2, 3 and 4, two additional items were added to the standard questionnaire. These were:

*Did you receive the **weekly clinical scenarios by email** encouraging you to access **AnswersIn**?*

YES NO

*If you answered **YES** to the above question, did the emails make you more likely to look at the **AnswersIn** website?*

YES NO

Please elaborate on your answer

As with the other items, respondents were asked to circle the appropriate response and provide free text feedback.

Results

Types of usage data available from Webalizer

Post exposure interrogation of the server revealed a large amount of information.

Initially the server provided crude usage statistics for the academic year (Table 7.3) including total hits (number of times the site was accessed), volume of data downloaded, number of visits and daily averages for each month for the academic year.

The increase in usage seen in June, July and August is consistent with the availability of *AnswersIn* to all three campuses during Block 4.

Approximately 200 hits were accounted for by initial testing by the development team. After 27/10/06 all the encounters were attributable to the study subjects accounting for approximately 2000 hits from a potential total pool of 178 GHEDNOH students over the year.

Each month's website activity could be further analysed to reveal a more detailed breakdown for a particular time period (e.g. April Table 7.4, Fig 7.1, Table 7.5)

Summary by Month									
Month	Daily Average				Monthly Totals				
	Hits	Files	Pages	Visits	KBytes	Visits	Pages	Files	Hits
Aug 2007	5	2	4	2	2237	53	102	65	136
Jul 2007	15	8	10	5	11040	155	320	258	488
Jun 2007	13	6	7	3	11209	111	230	194	392
May 2007	4	2	3	1	2124	46	90	62	148
Apr 2007	1	0	1	0	1521	25	52	26	57
Mar 2007	3	1	3	1	3256	48	98	45	105
Feb 2007	4	1	3	2	1765	61	107	42	112
Jan 2007	5	2	4	2	2731	62	121	58	147
Dec 2006	4	2	2	1	3424	34	67	61	109
Nov 2006	8	5	4	1	7704	56	133	162	266
Oct 2006	7	3	5	1	4949	53	148	100	209
Sep 2006	1	0	1	0	1187	17	31	22	40
Totals					**53148**	**721**	**1499**	**1095**	**2209**

Table 7.3- *AnswersIn* usage totals for the academic year as presented by Webalizer

Monthly Statistics for April 2007	
Total Hits	**57**
Total Files	**26**
Total Pages	**52**
Total Visits	**25**
Total Kbytes downloaded	**1521**

Table 7.4. Monthly statistics for April 2007

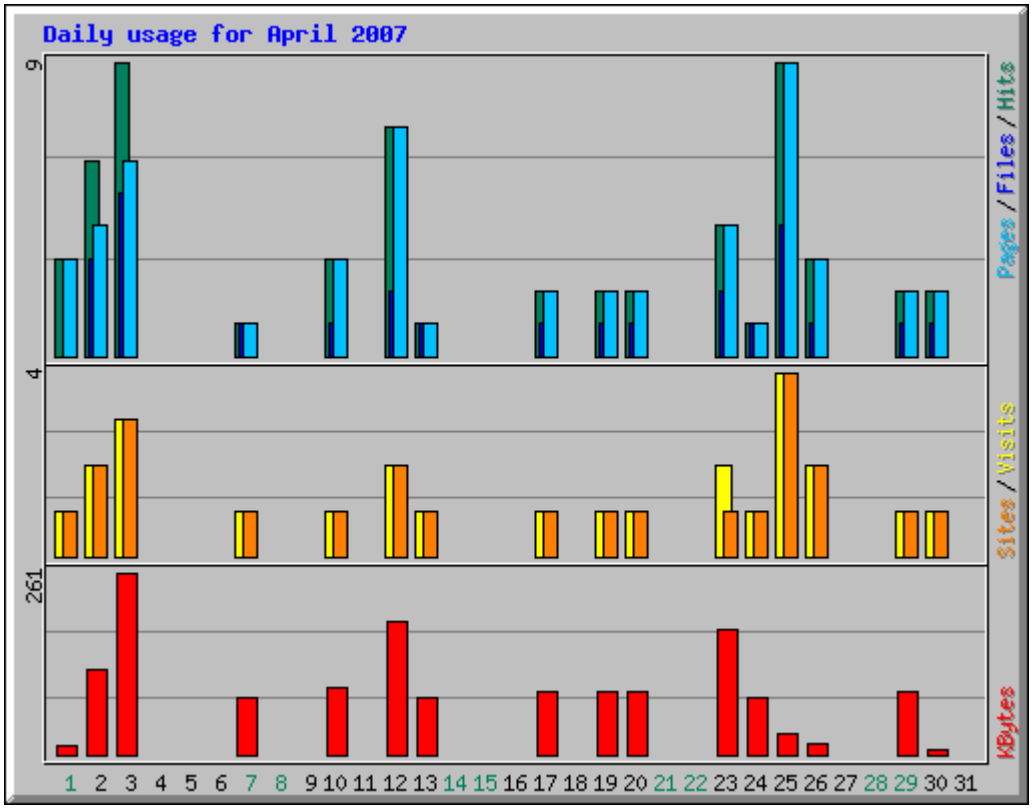

Fig 7.1. Daily usage statistics in April 2007 as presented by Webalizer©

Fig.7.1 demonstrates trends in activity. For example, the 25th of April was the date of the first push email advertisement for Block 3; it can be seen that this coincided with a rise in website hits, pages accessed and visits.

Daily Statistics for April 2007						
Day	Hits	Files	Pages	Visits	Sites	KBytes
1	3	0	3	1	1	14
2	6	3	4	2	2	123
3	9	5	6	3	3	261
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	1	1	1	1	1	82
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	3	1	3	1	1	96
11	0	0	0	0	0	0
12	7	2	7	2	2	192
13	1	1	1	1	1	82
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	0	0	0	0	0	0
17	2	1	2	1	1	89
18	0	0	0	0	0	0
19	2	1	2	1	1	89
20	2	1	2	1	1	89
21	0	0	0	0	0	0
22	0	0	0	0	0	0
23	4	2	4	2	1	178
24	1	1	1	1	1	82
25	9	4	9	4	4	31
26	3	1	3	2	2	14
27	0	0	0	0	0	0
28	0	0	0	0	0	0
29	2	1	2	1	1	89
30	2	1	2	1	1	8

Table 7.5. Tabulated breakdown of daily statistics for April 2007 as displayed by Webalizer©

It is also possible to look at average activity on the *AnswersIn* site over a 24 hour period for any given month in the study period (Fig 7.2.)

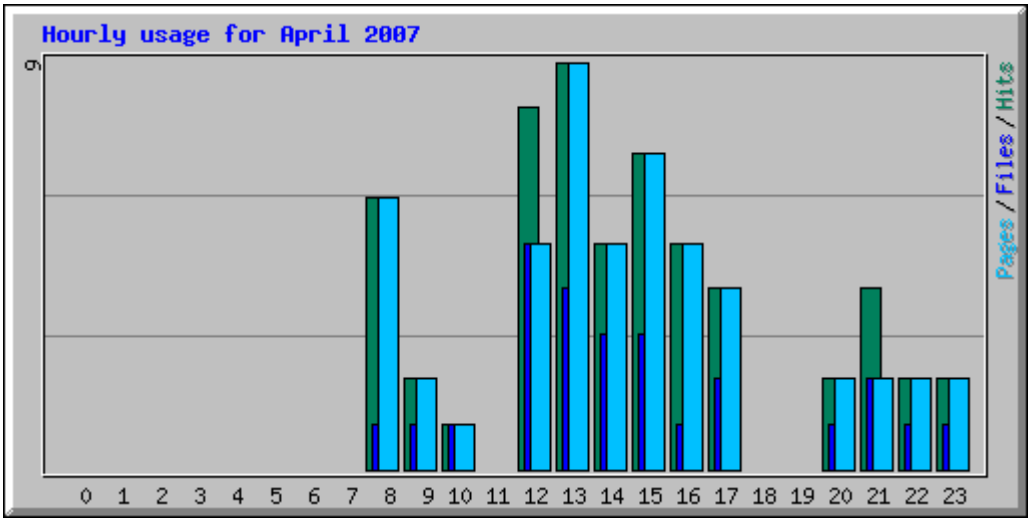

Fig 7.2- Average hourly usage of *AnswersIn* for April 2007 displayed by Webalizer©

From the histogram in Figure 7.2 we can see that the majority of activity occurs after midday. For April 2007 there is an absence of activity during 1800 and 1900 hrs which is the exception rather than the rule with other months typically showing higher levels of activity in the evenings with less in the afternoons.

An example is illustrated in Fig 7.3 which shows hourly activity for January and March 2007. Here we see a more representative usage pattern with little or no activity between midnight and 0700hrs followed by a gradual increase, peaking in the early evening before diminishing again towards late evening.

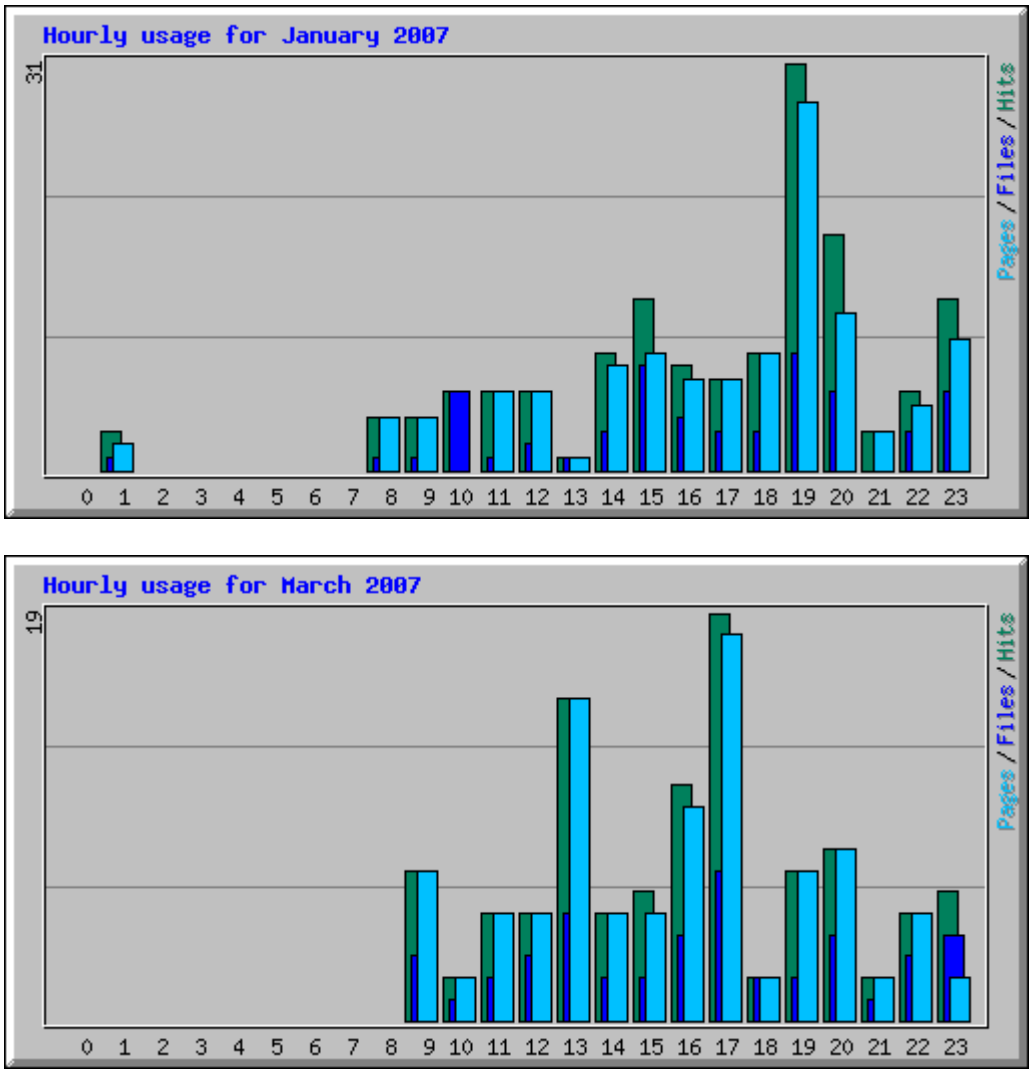

Fig 7.3. Hourly activity for January & March 2007

The server also gave information on the most popular *AnswersIn* pages visited as well as most popular *AnswersIn* pages downloaded as interviews or PDFs (Table 7.6).

Top 5 of 5 Total URLs- April			
#	Hits	KBytes	URL
1	18	1237	/medicalschool/answersin/
2	8	7	/medicalschool/answersin/homepage.html
3	3	52	/medicalschool/answersin/PDF/hm3pdf.pdf
4	1	27	/medicalschool/answersin/PDF/hm1pdf.pdf
5	1	22	/medicalschool/answersin/PDF/hm2pdf.pdf

Table 7.6. Most popular *AnswersIn* pages indicated in Webalizer for April

The most frequent/heaviest users of *AnswersIn* could also be identified and in addition, a Microsoft Excel© file was generated which detailed the exact number of times *AnswersIn* was accessed, by whom (i.e. their student ID), their Internet Provider ID and the time of access. This file was in chronological order and represented all activity on the website over the academic year. An anonymised sample is shown in Table 7.7.

Host internet provider	Student email ID	Date & Time
host-84-9-45-118.bulldogdsl.com	Student A	[08/Aug/2007:21:37:07
uclusers-cts45.uclusers.ucl.ac.uk	Student B	[08/Aug/2007:21:49:15
bb-87-80-169-29.ukonline.co.uk	Student C	[08/Aug/2007:23:13:09
bb-87-80-169-29.ukonline.co.uk	Student B	[08/Aug/2007:23:13:10
5ac3d2e2.bb.sky.com	Student A	[08/Aug/2007:17:50:50

Table 7.7. Excerpt from total usage file

Effect of Advertising *AnswersIn*

The number of hits to the *AnswersIn* website and total volume of data downloaded was recorded according to the schedule described in Table 7.2. The results are tabulated below in Table 7.8 & 7.9 and displayed graphically in Figs 7.4 and 7.5.

Block	Pre-email hits	Post-email hits	Percent Change	Total hits
HC2e	107	134	**+25%**	241
HC3	113	138	**+22%**	251
MC4e	395	545	**+38%**	940

Table 7.8. Effect on hits of advertisement emails

Block	Data downloaded pre-email (Kb)	Data downloaded Post-email (Kb)	Percent Change	Total data (Kb)
2 (HC2e)	2848	1889	**-34%**	4737
3 (HC3)	3350	1777	**-46%**	5127
4 (MC4e)	11034	11340	**+3%**	22374

Table 7.9. Effect of advertising on volume of data downloaded

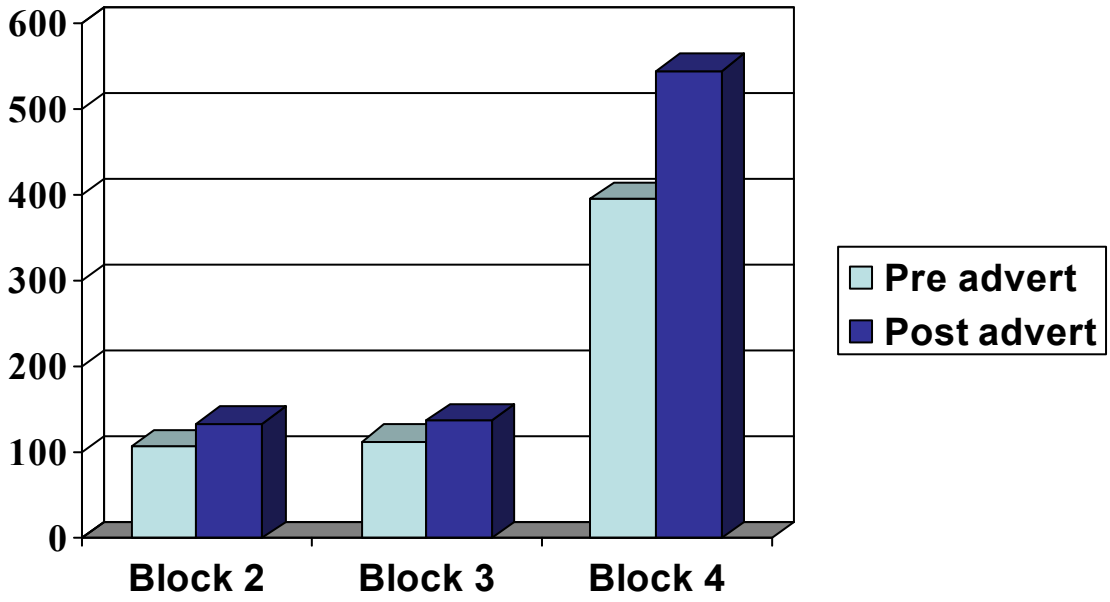

Fig 7.4. Number of hits before and after advertising email for blocks 2-4

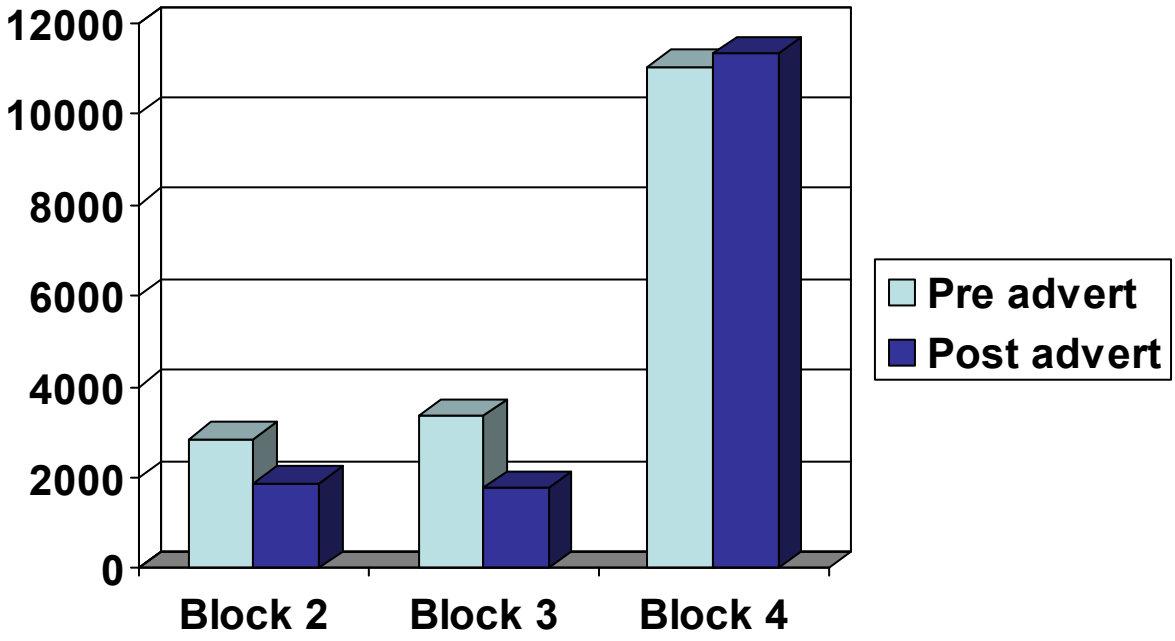

Fig 7.5. Kilobytes of data downloaded before and after advertising email for blocks 2-4

Questionnaire pertaining to advertising

The following items were added to the questionnaire for Blocks 2, 3 and 4 regarding the advertising email.

*Did you receive the **weekly clinical scenarios by email** encouraging you to access **AnswersIn**?*

YES NO

Of the 94 respondents that answered this first item, 90 (96 percent) answered "yes" with the remaining 4 percent stating that they did not receive the emailed clinical scenarios.

*If you answered **YES** to the above question, did the emails make you more likely to look at the **AnswersIn** website?*

YES NO

Please elaborate on your answer

Of the ninety student respondents who received the emailed clinical scenarios , 77 (86 percent) stated that the emails made them more likely to look at the *AnswersIn* website whilst 13 respondents (14 percent) stated they did not (Fig 7.6).

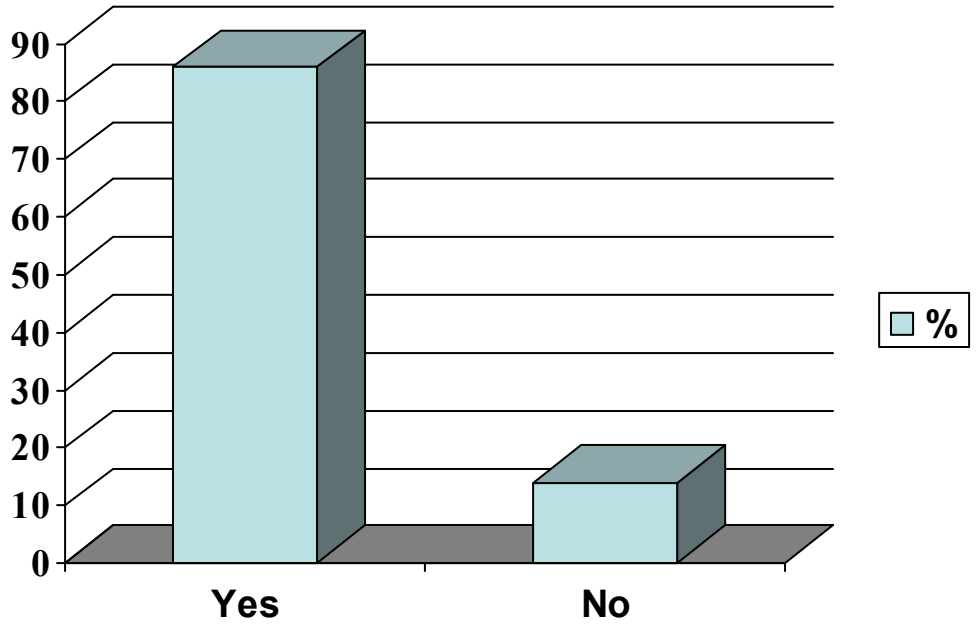

Fig 7.6. Responses of students when asked if the advertising messages made them more likely to look at *AnswersIn*

The free text responses to this second questionnaire item are detailed in Appendix K. Those who stated that the emails did not make them more likely to look at the *AnswersIn* website cited reasons including their tendency to delete unsolicited emails, examination stress and current active use of *AnswersIn* that did not require a "reminder".

A larger number of respondents who stated that the emails did make them more likely to access the site gave a variety of reasons. Among these was the curiosity about the answer to the question posed by the clinical scenario, the fact that the emails reminded them of the availability of *AnswersIn*, and a number stated that the

advertising emails were the only reason that they were made aware of the availability of *AnswersIn* in the first place.

Discussion

Types of usage data yielded

The examples in the results section above serve to illustrate the fact that a large amount of detailed information is available to teachers and curriculum committees when the appropriate software is used to interrogate servers that host web based CAL resources.

The software can yield:

- A quantitative breakdown of the number of hits, number of visits, pages accessed and volume of information downloaded over the course of a day, week and month.
- A graphical indication of the pattern of usage, as measured by these parameters, over hours, days and months.
- A "top ten" of most frequent users as defined by the above parameters, as well as a similar ranking chart for most popular pages.
- A detailed breakdown of exactly when the *AnswersIn* site was accessed, from where and by whom over any given period of time.

All the data obtained can be exported to a spreadsheet from which the data can be disentangled and analysed according to the needs of the researcher.

The effect of advertising on the uptake of *AnswersIn*

From blocks 2 and 3 and particularly from the much larger block 4, it can be seen that there was a rise in the number of hits to the *AnswersIn* website and its constituent web pages as a result of instituting a weekly emailed clinical scenario advertising the *AnswersIn* site (Table 7.7). The percentage rise in hits post-advertisement for Blocks 2, 3 and 4 was 25 percent, 22 percent and 38 percent respectively. The overall rise in hits for all three blocks was 32 percent.

Of particular interest was the discordance of the effect of advertising on hits and the total volume of data downloaded. Apart from Block 4 where the numbers were comparable (11034 Kb pre- vs. 11340 Kb post-advert), the total data volume downloaded was unexpectedly *less* post-advertisement than pre-advertisement (Table 7.8). The reasons for this are not clear but may lie in the patterns of use obtained from the server. For each of Blocks 2, 3 and 4 the initial email informing the students about the availability of *AnswersIn* (not the mid-block advertising email) resulted in an initial flurry of downloading activity over the first few days before the usage pattern stabilised. It is possible that the students' initial interest and enthusiasm at the beginning of the block may have played a role. An example is given below in (Fig.7.7) where the first introductory email was posted at the beginning of the block on the 19th of March.

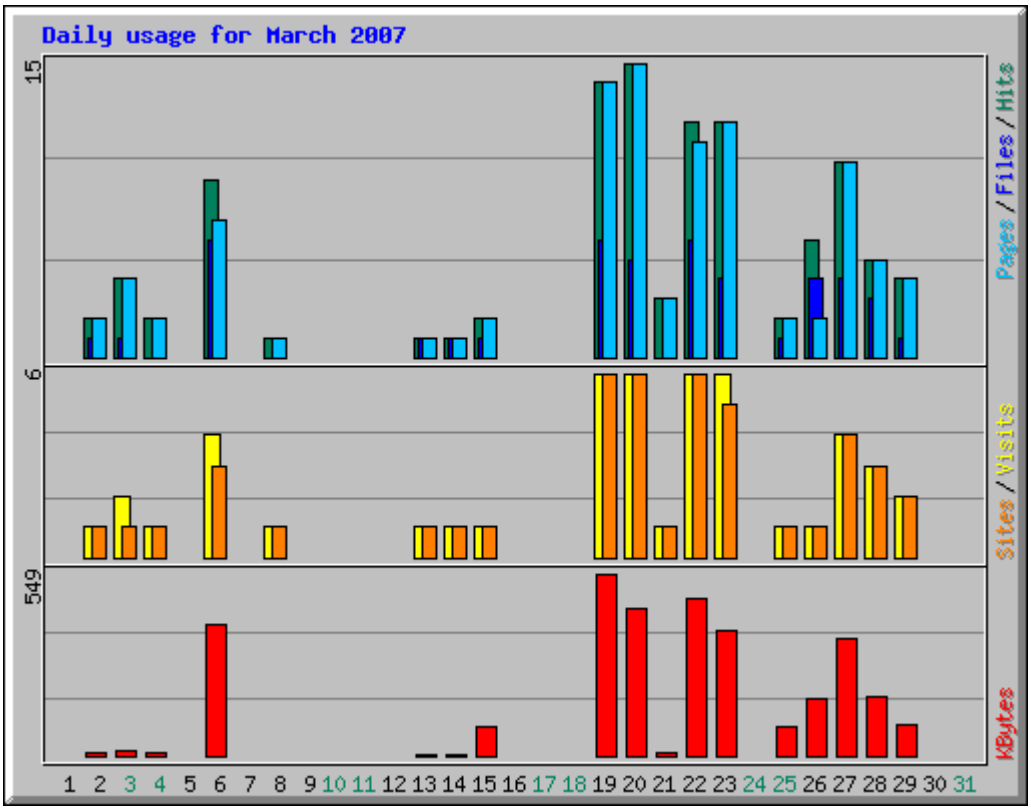

Fig 7.7. Increased volume of access and downloading at the beginning of block 2

The free text responses suggest that students who did not react to the advertising emails were those who did not pay too much attention to unsolicited emails and tended to delete them. Lack of time and the exam pressure was also indicated as a reason, suggesting that *AnswersIn* was not considered a mainstream learning resource. From the questionnaire it was also clear that there was also a student subgroup that were not influenced by the "push" emails as they had already adopted the resource and did not require additional motivation.

Some students who stated that the emails did make them more likely view *AnswersIn* commented that this was the first time that they were made aware of the resource and, but for the push email, would not have found out about the resource. This is despite the fact that at the beginning of each block the entire study group had been emailed

about the availability of the program. Other respondents indicated that the emails served as a useful reminder of the presence of *AnswersIn*. The usage data derived from Webalizer and the free text responses highlights the potential value of weekly advertising emails as a reminder to students rather than just making the site available and relying on a single introductory email.

Many of those who responded positively indicated a curiosity to know the answer to the question posed by the clinical scenario. This suggests that the benefit of the emails was not simply to advertise the availability of the resource but that the construction of the message in problem form was instrumental. The scenarios were constructed to appear plausible and appropriate ("you are on a ward round with the consultant" or "you are clerking a surgical patient when she asks you…") followed by a relevant question t that is just difficult enough to stimulate curiosity and a desire to seek the expert answer via the hyperlink to the relevant interview segment of *AnswersIn.*

Limitations

Whilst information derived from interrogating Webalizer© provides a wealth of potentially valuable usage information, the data is quantitative rather than qualitative. The date, time and web-page of each interaction are instantly available but the quality of the experience is not measurable. Ethical considerations and data protection precludes the identification of individual high and low users and it is likely that a small number of early adopters and enthusiasts skew the results further.

The dissemination of *AnswersIn* to a much larger study population in Block 4 seems to result in an increased effect of advertising on number of hits. Whilst this might support the impact of advertising, a confounding factor might be the pressure of end of year examinations which may equally have altered behaviour and this cannot be assessed from Webalizer©.

Conclusions

It is possible to extract a large amount of detailed data about the usage habits of study subjects exposed to a web based educational resource. This pertains to volume and type of data downloaded as well as temporal pattern and frequency of use. Information can also be extracted which would allow an individual user's activity to be tracked over time.

Whilst web usage provides useful information for providers of web-based learning resources, focus groups and questionnaires remain central to qualitative assessment. From the dataset it is also not possible to conclude that frequent use of the website validates the core content. The prime aim of *AnswersIn* is to offer a novel learning experience but the Webalizer data (table 6) indicates that after the homepages, the PDFs were the most popular access point. This suggests that students, in time-honoured fashion, opted not to engage with the interviews, but rather to download the PDFs for use as revision notes.

It would be of considerable interest to track individual patterns of web use and to use this data to identify different user subgroups. However, this approach raises ethical issues. While numerous confounding factors will most likely prevent confident

analysis of this data, it is possible to observe interesting trends in the patterns of usage which should prove valuable when scheduling more traditional forms of teaching in a blended learning environment.

Using both web-tracking and questionnaire, this study provides support for the use of advertising "push" emails to prompt students to access the application. The weekly emails may act both as a reminder and a "teaser" scenario which is clinically relevant and provides extra impetus. When developing an intranet/internet based CAL curriculum, carefully constructed push emails should be considered as an integral component of the delivery strategy.

Chapter 8- Conclusions

Answering the research Questions

The hypothesis proposed by this thesis was:

***AnswersIn*, an asynchronous learning multimedia CAL program built using the principles of Instructional Design and Adult Learning, is a feasible, accessible and acceptable means of teaching core topics in gastroenterology to 3rd year medical students**

Chapters 1 and 2 addressed the theoretical background to adult learning, Instructional Design and the current literature on Computer Aided Learning as it pertains to medical students. Chapters 3 to 7 addressed a series of questions posed by the hypothesis.

What constitutes "Adult Learning"?

In chapter 1, we examined attempts of scholars to find a definition of learning and the difficulties this posed.

Although pedagogy is a blanket term used to describe all forms of learning, its origins lie in the teaching of children. The pedagogical model reflects this in terms of its components such as dependence of personality, irrelevance of prior experience, absence of a "need to know", external motivation, readiness to learn and subject orientation of the learning process.

The chapter described those individuals and groups who, over the past two centuries, viewed the process of adult learning as essentially distinct from the pedagogical model and how this formed the basis of the adult learning movement. Andragogy was discussed as a recent phenomenon but essentially rooted in the teaching traditions of the ancient Greeks. The most notable proponent of Andragogy was identified as Malcolm Knowles and it was his model (an adaptation of Lindeman's pioneering work) which appeared to have had greatest influence on adult educators form the late 20th century onwards.

The key features of the Knowlesian model of Andragogy were discussed including the precepts that adults are goal oriented, need to draw on life experiences, need to be treated as equals, are internally motivated and able to productively engage in self-directedness in their learning activities. The overall conclusion from this review of how adults learn was that adult educators should embed the adult learning experience in any proposed framework.

<u>To what extent can the principles of adult learning and Instructional Design (ID) be incorporated into the design and content of a computer based instructional resource for clinical medical students?</u>

In the second half of chapter 1, the potential for applying the andragogical model to CAL was discussed with the position taken that a well designed CAL application or "learning object" could fulfil the needs of adult learners in a number of ways. Most significantly, well designed CAL programs could be non-linear in structure allowing

the user to control the pace of learning and capable of delivering learning at a time and place of the learner's choosing rather than at the convenience of the teacher.

The concept of the Andragogy was accompanied by an introduction to key concepts of Instructional Design (ID). The history and origins of ID were elucidated and the core components of the **ADDIE** model were described with reference to instruction in general and the process of developing CAL courseware in particular.

The chapter also examined the origins of multimedia technology and the concept of a cognitive theory of multimedia was introduced. This theory predicted that information presented in different ways to both auditory and visual pathways would result in differing levels of information transfer and retention. Based on this theory, a subsequent set of guidelines for designing multimedia programs was outlined. Furthermore the concept of heuristic evaluation for the assessment of CAL user interfaces was introduced, these heuristics being general rules that describe common properties of usable computer interfaces.

With the above in mind, we set out to create *AnswersIn Gastroenterology* as described in chapter 3 using the process described by the **ADDIE** model of Instructional Design.

AnswersIn is a FLASH© based CAL program designed to deliver core gastroenterology content to 3rd year medical students. *AnswersIn* comprises a series of short, stimulating *interviews* with on screen visual reinforcement providing a comprehensive curriculum in gastroenterology. Key features relevant to the principles

of adult learning included the ability to access *AnswersIn Gastroenterology* at the time and place of the learner's choosing, the ability to control the pace of learning and the provision of content considered relevant to the learner whilst they were immersed in their block of gastroenterology learning.

In line with the best principles of multimedia design, the audio and visual content was presented as a single synchronised learning experience designed to maximise transfer and retention and the user interface was designed for ease of navigation. The application was carefully edited, checked for errors and a consistency of style and appearance was established.

What is involved in the development of a suitable multimedia learning resource?

Chapter 3 described the process of creating *AnswersIn* within the **ADDIE** framework. There was a description of the student population under study and an outline of the wider MBBS curriculum structure at UCL.

Authoring, editing and recording of the source scripts was a major challenge as all these processes were new skills which had to be learned and implemented. Rapid development of curricular material in gastroenterology (and later in hepatology) was possible because the contributors involved in this project involved a gastroenterology trainee (NK) and consultant gastroenterologist (OE). A variety of peer-reviewed resources were used as a basis for script writing each topic. The chapter also described guidelines designed to assist interviewers and interviewees, none of whom had previously engaged in this form of recorded radio-style interview. The audio recording required a sound-proof environment and professional quality recording

hardware and after initial experimentation “in house” it became apparent that a professional recording studio was most suited to developing the digitised audio content.

The digitised audio was subsequently synchronised with the visual content presented on screen by sequentially appearing bullet points summarising the source script. The integration of the audio and visual source material required a full time computer programmer with graphic design and FLASH programming skills. Integrating the audio, text and graphics was a major constraint in the development process proving both time consuming and costly. This later resulted in a proposal for a simpler developmental template more suited to the time and budgets of a medical school.

Editing and proofreading was carried out partly by the authors and a part time project manager (TR) who helped coordinate the assembly of all the components.

Notional costs were calculated and it was estimated that to develop a module with the sophistication of *AnswersIn Gastroenterology*, a medical school would have to allocate around £130,000 of support.

Whilst the authoring, recording and integration of the CAL application was readily manageable, distribution on the medical school intranet was dependent on the goodwill fostered with the University’s IT department and the arrangements were informal.

As there was no requirement for official sanction for this supplementary learning resource, implementation of *AnswersIn Gastroenterology* was possible without the anticipated bureaucratic minefield.

AnswersIn Gastroenterology has been labour intensive and relatively expensive exercise presenting all the upfront costs of producing high quality multimedia rich resource. Individuals or groups wishing to develop multimedia CAL need to specify and cost each step in the process and the application developed for this thesis can provide a useful reference point.

The end product fulfilled the specifications set out prior to development and the software performed satisfactorily as a novel multimedia teaching program. In addition the end-product proved technically robust, reliable, easily accessible and able to deliver gastroenterology core content to the learners at their chosen time, place and pace.

Subsequent projects dealing with other subjects such as Respiratory Medicine and HIV have been embarked upon indicating that clinical tutors and clinicians outside the development team realised the benefits of *AnswersIn* as a reusable Learning Object (RLO) within their own specialty.

What access do medical students have to equipment that would allow them to access such multimedia learning resources?

Chapter 5 described the development and distribution of an electronic and paper questionnaire that probed 3rd year clinical medical students about their access to multimedia enabled computers suitably equipped for use with *AnswersIn Gastroenterology*. Further questions ascertained the location of suitably specified equipment and respondents' pattern of computer usage.

The email response rate (46 percent) was in line with expected outcome for this form of questionnaire distribution and acquisition. The email response was also validated by delivering an identical paper-based questionnaire to a further hundred students at a similar stage of their clinical training. The response rate was 100 percent.

The results showed that the majority of students accessed a computer daily and an even greater percentage had access to a computer both at work and in the home/term-time environment. Whilst most, although not all students, indicted that their home based personal computers were specified to deliver multimedia content (i.e. possessing a sound card, speakers and broadband access), most computers available for use in their place of work/study fell well short of requirements.

Half the students possessed an MP3 player or iPod which might provide an alternative media device capable of satisfying the requirements of "anywhere, anytime" audio or audiovisual CAL. Whilst the scene seems well set for the delivery of feature rich multimedia CAL to UCL medical students, the observation that most

but not all students have access to well specified home computers raises the important issue of equality of access.

It is possible that falling prices and the development of inexpensive media devices such as audio and video iPods and MP3 players and a new generation of inexpensive "netbooks" might soon allow universal access. The findings also suggested that the preferred place of access for many students is within the home environment, perhaps because University based computers are not adequately specified.

What methods can be implemented in order to evaluate student responses to this resource?

3rd year medical student responses to the utility and design of *AnswersIn Gastroenterology* were initially gauged by a questionnaire and focus group.

The questionnaire enquired about the utility of the key components of the resource and queried its technical robustness. Suggested improvements and its potential place in the curriculum were also interrogated. To validate the questionnaire, the questions were first piloted with a limited number of students and, following an assessment of the pilot responses, the questions were altered for distribution to the four study cohorts described in chapter six. The response rate to the questionnaire was maximised by direct distribution and collection from the respondents rather than via email or post, resulting in an 80 percent response rate.

The questionnaire was initially administered only to students at the Hampstead campus and in the final block, to all three campuses. The responses demonstrated that the *AnswersIn Gastroenterology* module was technically robust, reliable and easy to use when hosted on the University server and accessed via the internet. The utility of the *interview* style was deemed to be greater than the other components but all were considered more useful than not.

Students did not regard *AnswersIn Gastroenterology* as a replacement for lectures or seminars but rather as a valuable supplement which they wished to have extended to other subjects and systems. Reasons cited for supporting the traditional lecture-seminar based curriculum included perceptions of loss of interaction with a "real teacher" who could respond to questions and comments in real time and a perception that lecture-seminar courses carried the endorsement of the institution and teachers who set exams. Students who supported *AnswersIn* as their main study resource were in a minority, and a characteristic of this group was their stated preference for retrieving and deriving knowledge from a variety of resources.

Suggested improvements to *AnswersIn Gastroenterology* included more "exam style" material and closer integration into the curriculum. This is in keeping with medical students' goal-oriented nature and reinforced the need for CAL initiatives to be firmly endorsed by the curriculum committee and teachers, and for students to acknowledge this endorsement of the resource in and amongst their other learning opportunities.

In addition to the questionnaire, a focus group was employed to evaluate the application. Two groups of student volunteers were engaged to offer their views on

AnswersIn Gastroenterology. Verbatim transcripts of the focus groups were analysed and the emergent themes provided a rich source of insights. Unlike the questionnaire where responses are personal and dictated by the question, the focus group facilitated group interaction which helped participants crystallise responses. This served to underscore the value of the focus group as an important assessment methodology in the repertoire of indicators available for CAL developers wishing to improve their resource.

Themes that emerged from the focus group included consensus that *AnswersIn Gastroenterology* was an engaging and easy to use format that was technically robust when delivered on CD-ROM. The students expressed enthusiasm for the use of CAL but that there was concern about potential erosion of the student-teacher relationship. Students placed a premium on the identity and status of the interviewee and were concerned about current inequalities in teaching provision for apparently equivalent modules across the three medical school campuses.

<u>What are the logistics involved in providing this resource to defined populations of students?</u>

Whilst, in the pilot study outlined in chapter four, *AnswersIn Gastroenterology* was distributed using the CD-ROM format, dissemination to a larger group of students via CD-ROM would have been expensive and difficult to disseminate with no way of objectively monitoring use. The *AnswersIn Gastroenterology* application was therefore disseminated online via the University server where it was also possible to evaluate stability.

Transferring the FLASH program from development computer to university server proved problematic because of unexpected technical problems. Most of these problems, including protocols governing the naming conventions used on the server, were not anticipated and required considerable additional development work to correct.

When ready and appropriate permissions obtained from medical school authorities, the availability of the *AnswersIn* module was advertised to the students on the Hampstead campus using an introductory email which included a hyperlink to the site as well as a link to a Web log. Once operational, no further technical difficulties were encountered and the students were able to access *AnswersIn* without difficulty. Following three blocks of use on a single campus, the module was then rolled out to students on all three campuses and again, the students had no difficulties accessing *AnswersIn Gastroenterology* which functioned faultlessly throughout the four block assessment.

AnswersIn Gastroenterology is a robust multimedia rich resource and it was apparent that using the University server and intranet provided fast access to a large number of students across a multi-campus medical school needing no additional technical support once published on the intranet.

How can uptake of the resource be monitored and what is the effect of advertising on uptake of the resource?

As demonstrated in chapter seven, monitoring patterns of usage of *AnswersIn Gastroenterology* was readily achieved using Webalizer©.

Events available for analysis included numbers of hits, numbers of visits, page visits and amount of data downloaded during any specified month, week or day. In addition, it was possible to comment on patterns of use over a 24 hour period providing useful insights as to where *AnswersIn Gastroenterology* fitted into the students' daily schedule. Webalizer also provided data on the location of the student, the identity of the student accessing the module and the time of access.

The effect of sending an advertising email, in the form of a clinical vignette with a following question, halfway through the block was examined for a single campus in blocks 2 and 3 and for all 3 campuses in block 4. The number of hits for an equal number of days before and after the first of the weekly email messages was measured and this indicated a greater number of total hits after the message than before it. This effect was seen in the two blocks monitored on the Hampstead campus and the effect was more pronounced when all 3 campuses were targeted in the final block.

The items incorporated into the questionnaire enquiring about the receipt of the advertising email and its effect supported the server statistics by indicating that the majority of students received the advertising messages making them more likely to visit the *AnswersIn* website.

The combination of the quantitative server data combined with qualitative/ quantitative data obtained from the smaller focus groups followed by the larger cohorts allowed for a degree of triangulation thereby increasing validity.

What common challenges might be faced by others attempting to introduce CAL initiatives into a medical curriculum based on our experiences?

A number of common challenges encountered in the conception, production and distribution of *AnswersIn Gastroenterology* are likely to be encountered by others looking to develop CAL content for medical students This can be distilled into a set of guidelines which may be useful to those wishing to emulate the development process:

1. Identify need:
    - Identify that there may be a shortfall in supply of teaching of core content or a rise in demand in terms of student numbers/expectations.
    - Establish that within the target audience there is appropriate computer literacy and a desire to engage with CAL as a primary learning resource.
2. Test the theory behind any CAL initiative:
    - Ensure the content is developed with an understanding of the principles of adult learning.
    - Test the content and storyboard against the principles of adult learning best-practice.
    - Ensure that the principles of multimedia learning are adhered to in order to maximise retention and transfer of information.

- Develop a coherent and simple design for the user interface.
- Always ensure that the project follows a standard Instructional Design template e.g. ADDIE from its very inception

3. Engage the institution:

- Obtain appropriate permissions from the institutional educational head before communicating with students.
- Ensure familiarity with the curriculum in terms of goals, structure, and content as a "closer fit" will increase the likelihood of acceptance by students.
- At an early stage of development, identify the place of the CAL initiative within the existing curriculum.
- Involve the Curriculum Committee at an early phase of development; official recognition of the resource early on will increase the likelihood of integration into the curriculum and thus, student acceptance.

4. Establish the extent to which the target audience has access:

- Ensure that the target students have ready access to suitably specified hardware.
- Establish the likely pattern of use i.e. place and time.
- Identify and address any issues pertaining to equality of access.
- Tailor the product to ensure compatibility with the range of existing and emerging technologies likely to be used by the target audience.

5. Identify what material and personnel resources will be required and make budgetary/time allowances:

- Determine the level of expertise required to complete each phase of the production process and the scope of expertise required to script, record, storyboard, edit and integrate the production.
- As the production process usually takes longer than expected, set realistic production timescales and deadlines.
- Try to predict the expertise needed to maintain the production once up and running e.g. IT support for servers, production costs for updates, student help-desk support.
- Anticipate the need for a revenue stream that will allow the initiative to be delivered and maintained to expected standards.

6. Ensure the quality of the content:

- Use only up to date, widely respected and peer-reviewed sources when authoring content.
- Avoid infringing copyright - seek appropriate permissions and pay any royalties.
- Faithfully maintain the consistency of design of the CAL program and focus on the relevance of content for the target audience.
- Carefully proof read content to ensure a professional look and feel to the content.

7. Ensure that the CAL program is debugged and is likely to find favour with the target audience:

- Conduct small scale trials of the CAL program using selected members of the target audience.

- Check for synchrony between user needs and perceived needs using qualitative methods such as questionnaires and focus groups.
- Use small scale pilot studies to identify any weaknesses in the CAL program and use this feedback to correct these before going live.
- Ensure that the CAL program functions on all current delivery platforms (e.g. Windows XP, Windows Vista, Apple Mac operating systems.)

8. Maximise uptake potential of the target audience:

- Direct email contact is a cost effective method for ensuring that the target audience is aware of the availability of the resource.
- Consider stimulating access by advertising the resource using teaser messages likely to stimulate the user to click through to the resource.
- Emphasise the endorsement of the institution if possible and relevance to examinations.

9. Monitor uptake and gauge acceptance

- Use back-office software to monitor uptake of the resource (e.g. Webalizer©.)
- Monitor target audience acceptance and feedback by gathering post-exposure qualitative data e.g. in the form of questionnaires .

Review of hypothesis

***AnswersIn*, an asynchronous learning multimedia CAL program built using the principles of Instructional Design and Adult Learning, is a feasible, accessible and acceptable means of teaching core topics in gastroenterology to 3rd year medical students**

In summary this thesis has described the following:

1. An exploration of the principles of Adult Learning
2. A description of how a CAL resource in gastroenterology can be designed using principles of Adult Learning and Multimedia Theory
3. A demonstration of how such a resource can be conceived, developed, implemented and evaluated within the architecture of the ADDIE Instructional Design model for developing courseware.
4. Formative evaluation of *AnswersIn* using both qualitative and quantitative methods thus identifying it as a Proof of Concept which can be expanded to other specialties and further evaluated.
5. Use of the author's experiences to create a set of guidelines which may aid other potential developers of Computer Aided Learning resources for medical students

This thesis lends support to the underlying hypothesis and provides a basis for guiding teachers wishing to explore CAL in undergraduate medical learning.

Suggestions for further research

.Specific to *AnswersIn*

AnswersIn is a proof of concept which , by definition, has been assessed formatively within this thesis.

Further research needs to focus on establishing the validity of these findings, particularly with respect to:

1. The long term viability of the format and its applicability to other subjects besides gastroenterology

2. The possibility of closer integration within the RFUCMS curriculum and the effect this will have on student acceptance e.g. by following CAL modules with small group teaching thereby providing much needed interactivity and feedback opportunity

3. The possibility of closer association with examination content thus increasing acceptance by goal oriented medical students

4. An examination of the components of *AnswersIn* to identify what is most valuable to students e.g. if the interview style is most valuable versus the bullet points/images or PDFs.

General

The published literature on CAL in medical education is rich in comparative media studies and evaluations of CAL initiatives. There is consensus that CAL is as effective as traditional teaching.

More research is required that compares one form of CAL with another, rather than with the established methods. In addition, there is a paucity of information on the logistical journey faced by CAL innovators from first conception to final publication, its subsequent uptake and large group feedback.

More use should be made of focus groups to evaluate developments in medical education as this methodology is a great source of insights into student reactions to learning changes that challenges their inherent preference for a status quo.

CAL initiatives are usually instigated by enthusiasts and early adopters and the greatest challenge for those engaged in developing knowledge resources in the digital era is to harmonise best practice, continue to enquire and research the medium and encourage slow adopters through evidence

Research Governance declaration

Research Governance is needed to:

- Safeguard participants in research
- Protect researchers/investigators (by providing a clear framework to work within)
- Enhance ethical and scientific quality
- Minimise risk
- Monitor practice and performance
- Promote good practice and ensure lessons are learned

In line with these stated principles, the study design was disclosed to the UCL Data Protection Officer and University Ethics Committee.

The advice given was that the proposed studies were exempt from the requirements of ethical approval or data protection on the grounds that it was:

"Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behaviour UNLESS information obtained is recorded in such a manner that human participants can be identified AND any disclosure of the human participants' responses outside the research could reasonably place the participants greater at risk of criminal or civil liability or be damaging to the participants' financial standing, employability, or reputation".

Appendices

Appendix A

Crohn's disease 4a- Surgery Script

1.Surgery

Hello, I am continuing an interview with Professor Epstein on the subject of Crohn's disease. In this section, we will deal with surgical options. Prof Epstein, I assume there are times when surgery is necessary.

Absolutely. In fact, around 80 percent of patients with Crohn's disease ultimately require surgical intervention and resection of diseased bowel. Remember though that unlike ulcerative colitis, Crohn's disease is not curable by surgery. So surgery is almost always restricted to patients with complications or who are refractory to the full range of medical therapies.

I presume the major indication for surgery in small intestinal Crohn's disease, is structuring with obstruction and perforation?

Yes, and in some patients with short-segment stricturing or fistulating disease, surgery may be the most efficient means of restoring health and improving quality of life. And of course, surgery may also be indicated in disabling disease which fails to respond to the range of medical therapies.

And how does the surgeon approach surgery in Crohn's disease

The principle is to remove the least amount of small intestine possible and to focus on the local areas causing complications, such as obstruction, perforation, abscess or fistulation into an adjacent organ.

Can you describe how strictures are managed surgically?

Strictures can be managed by resection and it's not uncommon for the surgeon to deal with multiple strictures during the same operation. Strictureplasty is another option

What is strictureplasty?

This is a technique for relieving a stricture without excising the affected segment. A longitudinal incision is made through the narrowed area and this incision is closed transversely

So this is really a plastic procedure to widen the lumen?

Yes and strictureplasty is suited for patients with short, localized areas of fibrotic stenosis, and especially those at risk of short bowel syndrome due to previous intestinal resection

Appendix B

Crohn's disease 4a- Surgery – Bullets & Storyboard

1. SURGERY

Are there times when surgery is necessary? misc.clipart scalpel

- *80% of patients with Crohn's disease require surgical intervention at some point*
- *unlike ulcerative colitis, Crohn's disease is not curable by surgery*
- *surgery is restricted to patients with complications refractory to the full range of medical therapies*

What are the major indications for surgery in small intestinal Crohn's disease?

1. *short-segment stricturing*
2. *fistulation*

- *surgery may be the most efficient means of restoring health and improving quality of life*
- *surgery may also be indicated in disabling colonic disease which fails to respond to medical therapies*

How does the surgeon approach surgery in Crohn's disease?

- *remove the least amount of small intestine possible*
- *focus on the local areas causing complications*
- *complications include obstruction, perforation, abscess or fistulation into an adjacent organ*

How are strictures managed surgically?

- *strictures can be managed by resection*
- *uncommon for the surgeon to deal with multiple strictures during the same operation*
- *strictureplasty is another option*

What is strictureplasty? FF and NK animation

- *technique for relieving a stricture without excising the affected segment*
- *longitudinal incision is made through the narrowed area*
- *this incision is closed transversely*

Is this really a plastic procedure to widen the lumen?

- *reasonable to consider this a plastic procedure as no bowel is removed*

- *strictureplasty is suited for patients with short, localized areas of fibrotic stenosis*

useful in those at risk of short bowel syndrome from previous intestinal resection

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Appendix C

AnswersIn development costs

Template development costs			**Funding source**
Web-design and development	S Karas	18000	London Deanery
Web-design and development	Ffu Oct 04 -May 05*	21000.00	UCL Biomedica
Capital costs			
Laptop		1750	OE Special Trustees
PCs		2400	OE Special Trustees
PDAs		1000	OE Special Trustees
		44150.00	

GI modules - Total costs		**Total**	**Funding source**
Storyboarding costs	N Khan Oct 05 - Sept 06*	50000	OE
Recording costs	UCL vision	500	ESCILTA
	Air studios		UCL Biomedica
RFH contribution			
Farhana Haque	6hrs	600	
Marcus Harbord	1 hr	100	
Kate Steiner	2 hrs	200	
Richard Standish	3 hrs	300	
Owen Epstein	5 hrs		
Tim Rayne	640 hrs	25600	RFH
Flash integration costs	FF June 05 - Mar 06 as employee*	30000	UCL Biomedica
	Sean Gomer - freelance	13400	UCL Biomedica
	Clinton Gomer - freelance	10800	UCL biomed
Total		131500	

Hep modules - Total costs		**Total**	Funder
Storyboarding costs	N Khan Oct 06 - Mar 07*	50000	OE
Recording costs	Air studios	900	UCL Biomedica / ESCILTA
RFH contribution			
David Patch	and RFH time	100	UCL Biomedica
Michael Jacobs	and RFH time	100	UCL Biomedica
George Webster	and UCH time	300	UCL Biomedica
Geoff Dusheiko	and RFH time	500	UCL Biomedica
Farhana Haque	4 hrs	400	RFH
Clare Craig	1 hr	100	RFH
Paul	2 hrs	200	RFH
OE	4 hrs		RFH
TR	320 hrs	13100	RFH
Flash integration costs	FF Apr 06 - Oct 06 as employee	21000	UCL Biomedica
	FF - freelance	5700	UCL Biomedica
	Sean Gomer - freelance	1200	UCL Biomedica
Galleries and animations	Helena Wee	1500	UCL Biomedica
Total		95100	

Notes

Time/contribution given by RFH/UCH employees during working hours has been estimated at 100 pounds per hour

OE authoring hours unaccounted, reviewing hours unpaid

F Haque has been given a 30Gb video iPod for her contributions

* Includes on-costs (NI, pension contributions, office overhead)

This table also shows the costs incurred by a second module in hepatology which was created after gastroenterology was complete. In most respects, the hepatology module followed the template of gastroenterology.

Appendix D

AnswersIn Evaluation Questionnaire

Please Circle As Appropriate

How useful did you find the following sessions compared to how you normally learn gastroenterology?

(1 is not useful at all** and **5 is very useful)

Histology section	*1*	*2*	*3*	*4*	*5*
Image gallery section	*1*	*2*	*3*	*4*	*5*
Radiology section	*1*	*2*	*3*	*4*	*5*
The 'radio interview' style of AnswersIn	*1*	*2*	*3*	*4*	*5*

1. *Did AnswersIn work on your computer? YES/NO- Please elaborate on your answer*
2. *Do you see AnswersIn replacing formal lectures/seminars? YES/NO - please elaborate on your answer*
3. *Was AnswersIn easy to navigate? YES/NO - please elaborate on your answer*

4. *Would you like to see other subjects, besides gastroenterology, being covered using the AnswersIn format? YES/NO - please elaborate on your answer*
5. *Would you use AnswersIn as your main resource on a given topic? YES/NO - please elaborate on your answer*
6. *How do you think that AnswersIn could be changed to better meet your needs?*
7. *How old are you?*
8. *What is your gender? M/F*
9. *List any formal IT experience/ qualifications e.g. ECDL (European Computer Driving Licence)?*

Appendix E

Focus Group Themes

- What did you think about the design and user interface of *AnswersIn* and which aspects did you like or dislike?
- How effective was the "radio interview" format and what changes are recommended?
- Did *AnswersIn* provide you with a comprehensive overview of topics in gastroenterology?
- Did you feel that the content of *AnswersIn* fulfilled your learning needs and was it pitched too high, too low or at the right level?
- What importance did you attach to the identity and status of the interviewer and interviewee?
- Where do you see *AnswersIn* fitting in to the current or future undergraduate curriculum?
- Do you envisage that *AnswersIn* as a central resource for your learning needs in gastroenterology and possibly other subjects?
- How do you see CAL contributing to your curriculum?
- What do you perceive to be the preferred relationship between the traditional teacher role and CAL?
- Did you need to use the Web log? Was it useful?

Appendix F

AnswersIn pilot study recruitment flyer

ATTENTION ALL GHEDNOH STUDENTS

Dear student colleague

Welcome to your 10 week GHEDNOH block. We hope that you will enjoy a productive and informative attachment.

In our attempts to improve continually the way that you are taught gastroenterology, we have developed a novel multimedia learning tool called AnswersIn
AnswersIn is a stimulating, computer based program which allows the student to "learn on demand" i.e. all the factual and clinical information that a student needs can be learned in the home/library/other setting at a time of the student's choosing. Initial student responses to prototype programs have been very favourable but we need to conduct some form of formal testing.
We are looking to recruit a limited number of students from this GHEDNOH group to participate in a pilot study looking at the student response to AnswersIn.

What is involved?

We will give selected students a CD-ROM with the finished and fully functional AnswersIn Gastro module. This can be accessed by yourselves anywhere that you have access to a multimedia computer (one that has a CD drive and speakers). You

will have access to the disc for two weeks during which time we would ask you to use it whenever it is most convenient.

At the end of the two week period we would like you to attend a short interview, provisionally on Thursday 20th July, as a group which will be recorded (anonymously of course!) where an interviewer will ask your opinion about various aspects of the AnswersIn module (how good, room for improvement etc.).

Don't worry about any clashes with your other commitments. The AnswersIn disc can be accessed whenever is good for you and the interview will be held at a mutually convenient time. It will all be completed well before you need to start worrying about the end of block exams.

What's in it for you?

The AnswersIn module will hopefully be a good study aid for the end of block exams. You will be the first students to have access to a novel teaching technology which explores new ways of "learning on demand" and as a thank you, we will give all selected participants a free copy of the fully functional Gastro-Hep module when it is completed later this year.

If you would like to take part in this research project (who knows, it may lead to an SSM!) then please email Dr Nasser Khan (Professor Epstein's Research Fellow) at: n.khan@medsch.ucl.ac.uk. Alternatively, bleep 1019.

Appendix G

AnswersIn Evaluation Pilot Study Consent Form & Information Sheet July 2006

Dear Student colleague

Thank you for your interest in the AnswersIn pilot study. Below is a description of what is involved:

1. *On completion of this consent form you will be issued an AnswersIn disc. This disc contains a program which should automatically start when you insert the disc into your computer. Your computer needs to have a CD drive and speakers or earphones.*
2. *You will review the material contained on the disc at convenient times. You should aim to evaluate all the subjects covered in the AnswersIn module if possible.*
3. *Please return the disc to the study co-ordinator by 20/7/06*
4. *On the 20th of July 2006 you are invited to attend a 1 hour focus group to discuss your opinions about the project. There will be a short questionnaire at the beginning followed by the group discussion. This discussion will be led by a third party not involved in the development of the AnswersIn project. The discussion will be recorded and the transcripts analysed. Refreshments will be provided.*
5. *In return for taking part you will receive a complimentary copy of the full Gastro/Hep AnswersIn module when it is completed (September 2006)*

Your participation in this study is entirely voluntary and your written and recorded information will be kept strictly confidential and anonymous. The audio tape will

be destroyed three months after the recording. Agreement or refusal to take part in this study will in no way impact on your standing as an undergraduate medical student.

Please sign and print your name below, adding the date today, if you agree to the above and wish to participate in this study

I have read the above and wish to participate in the AnswersIn evaluation study. *Signature……* *Printed Name……* *Date……*

Appendix H

Multimedia Access Questionnaire

Multimedia Questionnaire- Please Tick As Appropriate

1. **How often do you use a personal computer? (please tick)**
   - Every day ☐
   - Every few days ☐
   - Every week ☐
   - Less Frequently ☐

2. **Do you have access to a personal computer at home? (please tick)**
   - Yes ☐
   - No ☐

3. **Do you have access to a personal computer at your place of work/study? (please tick)**
   - Yes ☐
   - No ☐

4. **Which of the following features does your computer at home have?(please tick all that apply)**
   - Sound card and speakers ☐
   - The ability to listen with headphones ☐
   - Broadband internet access ☐
   - Dial-up internet access ☐
   - A CD-ROM or DVD-ROM ☐
   - Email ☐

5. **Which of the following features does your computer at work/place of study have? (please tick all that apply)**
   - Sound card and speakers ☐
   - The ability to listen with headphones ☐
   - Broadband internet access ☐
   - Dial-up internet access ☐
   - A CD-ROM or DVD-ROM ☐

- Email ☐

6. If you have indicated that you have access to a personal computer at both home and work. At which location do you spend most time using a computer? (please tick)

- At home ☐
- At work ☐
- Both approximately equal ☐

7. Which of the following devices do you own, or have easy access to? (please tick all that apply)

- MP3 player (any type) ☐
- Handheld PC/PDA ☐
- iPOD ☐

8. Which of the following have you used in your studies in past? (please tick all that apply)

- Electronic learning resources ☐
- Interactive self-assessment tools ☐
- Virtual learning environments eg: WebCT ☐
- Educational websites ☐

9. If you selected any of the above, please list any that you found useful.

_____

_____

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Thank you for completing this questionnaire

Appendix I

Email informing the GHEDNOH students about the availability of AnswersIn

Dear GHEDNOH student

You may be aware that one of the major interests of the department of Gastroenterology is in medical education and its effective delivery. We have produced a novel multimedia teaching tool called AnswersIn which contains all the core knowledge you need for luminal gastroenterology. Hepatology is under development but currently unavailable. *Assimilation of the information in this module is a requirement of your GHEDNOH block*. The other gastroenterologists (Dr Keshav and Dr Hamilton) and I will expect you to have a grasp of the key concepts outlined in the module as the basis for your clinical teaching.

The AnswersIn module can now be accessed from this website with your IS identification:

http://www.ucl.ac.uk/medicalschool/answersin/

The resource requires a computer equipped with broadband and speakers/headphones. Navigation of the site is largely self-explanatory. For those of you who have problems going online, a CD-ROM version of the programme can be obtained by contacting my research fellow, Nasser Khan on n.khan@medsch.ucl.ac.uk. These discs will have to be signed for and must be returned at the end of the GHEDNOH firm. Dr Khan is also your main point of contact for queries about any aspect of the teaching program.

Online support is available on a dedicated Blog which you should use for making any factual or technical enquiries after you have signed in as a "blogger". We are always looking for constructive criticism of our work and the blog can be used for this as well.

The blog will be checked daily and your questions answered as quickly as possible. The blog can be found here:

http://answersinsupport.blogspot.com/

We hope you enjoy exploring the world of AnswersIn and look forward to hearing your comments. Your formal opinions and experience on the module will be assessed at the end of the firm. This module is currently exclusive to the Hampstead Campus.

Finally, please confirm that you have received and read this message by contacting my research fellow, Dr Nasser Khan, on n.khan@medsch.ucl.ac.uk.

Best wishes

Prof. Owen Epstein

Appendix J

Freetext- Non-participants/users that left comments

- No time due to exam stress
- No time- prefer Kumar & Clark
- Never heard of it
- No time due to exams
- Did not use as still plenty of time until exams so no pressure
- Use books instead
- I wish I had known about it before now!
- I had too many emails to open and only one section (gastroenterology) worked
- Never really got 'round to it although I plan to use it as a supplement to my revision
- So much revision/clinical work to do that I never really got 'round to it. Sure it is a very good resource though…
- Very slow when you get on the site so I gave up on it
- Prefer to get my learning from a library book than online
- Did not like to revise from computer screen. Therefore looked up answers in books, notes and tutorials with Prof Epstein & Dr N Khan

Appendix K

All Freetext Responses

(NB omitted question components are those for which there were no responses)

Phase 1 Hampstead

Do you see AnswersIn replacing formal seminars/lectures? YES

- Gives all the info of seminars but in your own time
- It should replace them because it is in your own time, at your own pace so you can go back if you don't understand. Plus there is no consultant to terrorize us!
- Can do in your own time and Livenet never works anyway!
- Lectures make me sleepy!

Do you see AnswersIn replacing formal Seminars/Lectures? NO

- It is incredibly useful to use in my own time but not able to answer questions
- Although useful, there is something engaging about "real" lectures
- Seminars are useful but it could replace lectures
- AnswersIn better for knowledge consolidation
- Can play a bigger part but not totally replace lectures
- Seminars provide a useful overview and AnswersIn reinforces this. They complement each other
- Cannot guarantee that self directed students will work hard enough!
- Works well in conjunction with lectures
- Oral dissemination of knowledge is still best
- Would be better as 50:50- best to team up AnswersIn with tutorials
- More of a revision aid

- Perhaps fewer lectures but not a total replacement
- No opportunity to interact/ask questions

Was AnswersIn Easy to navigate? YES

- Very well laid out and user friendly
- Easy to follow and clear instructions
- Very straightforward
- Well organised
- Very user friendly
- Clear layout
- user friendly
- Easy to stop and start interviews

Would you like to see other subjects besides gastroenterology covered using the AnswersIn format? YES

- Definitely. More useful than many books. Should be available for ALL subjects
- All subjects please!
- All major specialties
- Every specialty
- All modules please
- Helps to clarify grey areas in knowledge
- Important subjects such as respiratory and cardiovascular medicine
- Please get the other specialties to contribute
- Defo!
- Radiology

Would you use AnswersIn as your main resource on a given topic? YES

- It's actually fun so I ended up studying more
- I would rank it highly
- Would be my main resource
- Provides adequate detail
- Only if we knew that the exams would be based on AnswersIn
- Yes, if it follows the syllabus
- Especially if the creators of AnswersIn know what we need to know for the exam!

Would you use AnswersIn as your main resource on a given topic? NO

- A bit too detailed
- Mainly textbooks
- Textbooks as well
- Prefer text but it is a useful supplement
- Books are my first resource as I don't learn well from a VDU
- Still need to make notes from textbooks
- Not enough detail
- I prefer lecture notes for revision
- I need paper
- I always use a variety of resources

How do you think AnswersIn could be changed to better meet your needs?

- More questions in quiz or MCQ format
- Links to additional resources
- No changes needed!!
- The ability to save the images on your PC
- Download onto MP3/iPod

- Broader range of topics
- More test questions
- More exam style questions
- More MCQs
- Give the information that is necessary for exams

Phase 2 Hampstead

Do you see AnswersIn replacing formal lectures on the same subject? YES

- Can access at a time that is convenient to you
- More useful and can be in one's own time
- Can replace most lectures
- More succinct and relevant
- Could access AnswersIn at a more convenient time and revisit topics if necessary

Do you see AnswersIn replacing formal lectures on the same subject? NO

- A useful supplement but not total replacement
- Prefer it to Livenet but not a live lecturer
- Lectures are more personal
- Good tool to use after a lecture but no opportunity to ask questions there and then
- Useful revision tool but interactivity of lectures is valuable
- If there were no compulsory lectures then many students wouldn't bother
- Opportunity to ask questions in lectures
- They complement each other. you need a variety of resources
- I found lectures very helpful

Do you see AnswersIn replacing formal Seminars on the same subject? NO

- Seminars are interactive
- Small group teaching is useful to me
- AnswersIn is not as interactive
- Seminars more interactive
- Small group teaching has been the most useful way to learn
- You cannot ask questions
- Seminars give the opportunity for discussion
- Still very important to have somebody to answer your questions
- Face to face is necessary
- Need to be able to ask questions
- Seminars tend to be interactive which is a good way to learn

Was AnswersIn Easy to navigate? YES

- Simple and intuitive
- User friendly interface
- Clear format
- Bullet point system offers good user interface
- Easy to find the topic
- Clear and easy
- Very user friendly
- Very straightforward

Would you like to see other subjects besides gastroenterology covered using the AnswersIn format?

YES

- CVS and resp
- All the specialties
- Would be good to have the other medical specialties
- Yes please! Especially for revision

Would you use AnswersIn as your main resource on a given topic? YES

- Yes because I found it easier to learn from
- In some cases it was easier to remember
- Would normally use books but the clinical relevance is more useful in AnswersIn

Would you use AnswersIn as your main resource on a given topic? NO

- Prefer books but AnswersIn good for reinforcement
- Textbooks preferred
- Nicely detailed
- Only as a revision aid
- You would be unsure if you had learned everything you needed to know
- Books as well
- I am still a book person. If the Medical School said I only needed AnswersIn then I would consider it
- It's a bit overwhelming
- I would use it but not exclusively

How do you think AnswersIn could be changed to better meet your needs?

- A search option
- Videos of the interviewees
- Downloadable audio for MP3
- More subjects

- Be relevant to the curriculum- what we need to know only
- More direct links to the subsections
- Sample MCQs
- Highlighting of key points- difficult to tell what is general and what is key
- Faster download

Did the emails make you more likely to look at the AnswersIn website? YES

- I was curious to know the answers
- Motivates you to find the answer
- Served as a reminder that AnswersIn was available
- Useful as a motivational tool
- Reminded you it was there and allowed you to focus on a specific topic
- Few things that I'd never heard of which I had to look up
- It served as a gentle reminder
- Yes, they directed you to an area

Did the emails make you more likely to look at the AnswersIn website? NO

- Not really

Phase 3 Hampstead

Would you like to see AnswersIn replacing lectures on the same subject? YES

- Students can work at their own pace
- Yes if the lack of interaction could be overcome with a questions forum

Would you like to see AnswersIn replacing lectures on the same subject? NO

- I don't think it can replace the interaction of a lecture

- AnswersIn would complement a lecture
- lectures are in more detail
- Lectures still have their place- not all students would use AnswersIn if they don't have to and learning isn't being forced upon them!
- Ability to ask questions in lectures
- Need to be able to ask questions
- I prefer seeing someone in front of me

Would you like to see AnswersIn replacing Seminars on the same subject? NO

- Seminars can be very useful learning tools
- Always good to have a lecturer- a chance to ask questions
- Give you an opportunity to clarify misunderstandings
- AnswersIn as an adjunct would be good- to reaffirm what you know
- Seminars involve interaction
- You can ask questions in seminars
- Seminars extremely useful
- Good to have different perspectives on the same subject
- In case there are questions

Was AnswersIn easy to navigate? YES

- I found it very easy to work
- Simple to use
- Easy to follow instructions and clear layout
- Very user friendly
- V. helpful

Would you like to see other subjects besides gastroenterology being covered using the AnswersIn format? YES

- Nephrology and endocrinology
- Great if all subjects could be covered
- Nephrology
- All subjects
- Haematology
- Would like it to cover other subject areas
- All other modules in GHEDNOH because it was excellent for gastro
- All subjects
- Yes it was an excellent resource

Would you use AnswersIn as your main resource on a given topic? YES

- The tutorials make it stand out from other resources

Would you use AnswersIn as your main resource on a given topic? NO

- Would still use textbooks but AnswersIn would be a great supplement
- prefer books but it is a great supplement
- As a supplement to Kumar & Clark but not exclusively
- But it would be one of the most useful
- It's still relatively new. Would like to use it when it is more established
- Still prefer textbooks
- I prefer books

How do you think AnswersIn could be changed to better meet your needs?

- AnswersIn is good but it is much nicer reading a book than looking at a computer screen
- A discussion forum should be integrated into the AnswersIn programme rather than a separate provision
- More topics
- Other specialties covered

Did the emails make you more likely to look at the AnswersIn website? YES

- They are the reason I looked at AnswersIn
- By not knowing the answer to the question, it made me look up the website to solve the problem
- reminded me that it was there
- Encouragement
- Definitely. I read the first email and thought it was a useful resource but the reminders were useful
- All the time!
- Made me curious to look up the answer
- I was interested in finding out the answers

Did the emails make you more likely to look at the AnswersIn website? NO

- Some might find the delete button too easy to hit!

<u>Phase 4 Archway</u>

Would you like to see AnswersIn replacing lectures on the same subject? YES

- Like doing it on my own time
- Allows you to learn at your own time and pace

Would you like to see AnswersIn replacing lectures on the same subject? NO

- But can be done together
- Even though AnswersIn is really helpful, lectures can be interactive
- Lectures still play an important role because of interactivity
- Yes in theory but there must be more discipline
- I think that this is just medical education on the cheap- trying to save money as usual!
- Not fully replace but found it really useful
- Lectures highlight important points

Would you like to see AnswersIn replacing Seminars on the same subject? YES

- Like doing it on my own time
- yes, seminars aren't able to be paused

Would you like to see AnswersIn replacing Seminars on the same subject? NO

- prefer interaction of group teaching
- Ability to ask questions
- You couldn't ask questions
- The medical school is cutting back again!
- Allows you to ask questions about parts that you do not understand
- Seminars allow students to ask questions

Was AnswersIn easy to navigate? YES

- Simple

Would you like to see other subjects besides gastroenterology being covered using the AnswersIn format? YES

- Endocrinology
- The more the better as AnswersIn is really useful
- All other subjects
- We don't get renal teaching so that would be helpful
- Would be VERY helpful!
- DEFINITELY! especially endocrinology. I want all of medicine to be available in this format
- Pathology

Would you use AnswersIn as your main resource on a given topic? YES

- Excellent for revision
- Possibly

Would you use AnswersIn as your main resource on a given topic? NO

- Good for understanding but not revision
- Would use in conjunction with books
- It is my main resource for gastro
- Excellent revision but not sufficient on its own
- I trust the content of reputable books more
- Different methods of learning help consolidate info
- I still find books helpful
- Gastroenterology textbooks

How do you think AnswersIn could be changed to better meet your needs?

- Questions on the website
- Slightly more clinical detail
- More topics
- Radiology
- Include other subjects
- Searchable topic base

Did the emails make you more likely to look at the AnswersIn website? YES

- It made me realise that there was so much that did not know so the emails were a good push
- yes it is how I discovered it in the first place
- yes but I'm too busy!
- if I was unable to answer the question, it prompted me to look at AnswersIn

Did the emails make you more likely to look at the AnswersIn website? NO

- Because I already looked at the site before!

Phase 4 Bloomsbury

Would you like to see AnswersIn replacing lectures on the same subject? YES

- Covers a lot of material- clear and organised
- I personally do not like lectures as they do not benefit the way I learn

Would you like to see AnswersIn replacing lectures on the same subject? NO

- Not a replacement but an addition
- Lectures are more interactive and questions can be asked

- You can't ask questions to a computer- part of the enjoyment is the enthusiasm of the lecturer
- Prefer to see someone in front of me
- More useful as an extra teaching tool
- lectures are much more personal
- Not replacing but supplementing through stronger integration
- Lectures are important but this is a good study tool and for revision
- Good to have both
- Good to have both resources

Would you like to see AnswersIn replacing Seminars on the same subject? YES

- You can do it in your own time
- Possibly

Would you like to see AnswersIn replacing Seminars on the same subject? NO

- Seminars are where we offer our knowledge too- an excellent way to identify what you don't know
- Useful as a supplement
- Need small group guidance for better learning
- Nothing can replace the interactivity
- Seminars allow you to cover what YOU find difficult
- Need specific questions answered
- Cannot be modified to a specific students agenda
- It would not encourage students to come in thus increasing "antisocial behaviour"
- Prefer face to face contact and the chance to ask questions
- Can ask questions
- More interactive
- good to have both resources

Was AnswersIn easy to navigate? YES

- Links and short cuts very useful
- Straightforward instructions
- Very well thought out style and easy to use

Would you like to see other subjects besides gastroenterology being covered using the AnswersIn format? YES

- AnswersIn should be used in all modules
- Would be useful to have a broad overview of common conditions
- Would be great to have hepatology
- Cardio, resp, endo , rheum
- All the gen med specialties as we only have teaching on half of them
- Yes if it was a comprehensive resource covering all medicine and surgery
- Yes, especially as we do not get teaching in all the topics covered in the general medical specialties
- Good to have all of them especially considering many of us do not get taught directly in most specialties
- All the gen med spec. In fact everything!

Would you use AnswersIn as your main resource on a given topic? YES

- Very thorough
- I already am for gastroenterology!
- Yes, if we were definitely examined on its content

Would you use AnswersIn as your main resource on a given topic? NO

- Use as a supplement
- It is great as an additional resource but not the only source
- Still need to read around subjects in more detail
- It is too detailed but good if you don't understand a subject
- Useful consolidation tool but not detailed enough
- Textbooks will always be my preferred source
- I find it easier to look at a book than a computer
- Not main source but definitely a good revision tool

How do you think AnswersIn could be changed to better meet your needs?

- PDFs should be slides rather than printed text alone
- More "textbook" style information
- Shorter interviews
- A bit too much detail at times
- Key points please and specific directions on history taking
- Very good as it is but more specialties covered please
- More visual aids
- Perhaps include video
- Much as the interviews were good, they were not as quick as reading
- Sometimes I did not have access to a computer so it was not very useful in this case
- Stronger integration with taught course
- Make the sections easier to load one after the other
- Access to more specialties
- Printable handouts

Did the emails make you more likely to look at the AnswersIn website? YES

- They reminded me of what I had forgotten
- reminded me of its presence

- They often highlight what you do not know
- Good reminder
- reminded me it was there
- Direct link and the email suggests a specific question
- Because I realised that I could not answer the question
- A little yes. If the question was on a topic I had not done then I would look at that topic

Did the emails make you more likely to look at the AnswersIn website? NO

- I went through all the topics already and knew where they would be

Phase 4 Hampstead

Would you like to see AnswersIn replacing lectures on the same subject? NO

- Can ask questions in lectures
- Good to have a lecturer there
- A more interactive lecture style aids memory
- Useful in addition to lectures
- Lectures still important to outline the important concepts
- lectures feel more structured

Would you like to see AnswersIn replacing Seminars on the same subject? NO

- Can ask questions in seminars
- prefer to have someone who knows the subject there to answer questions
- it is an adjunct not a replacement

- Seminars are more interactive
- Good to have interaction with a tutor

Was AnswersIn easy to navigate? YES

- But I found the galleries difficult to access at times
- Yes but galleries easy to miss
- Layout was simple and logical
- Sections were clear-cut

Would you like to see other subjects besides gastroenterology being covered using the AnswersIn format? YES

- Should be available for all topics
- Renal histology
- Hepatology
- More common conditions
- Was a helpful system where subjects were reinforced
- the gastro section was v.good so would like to see more

Would you use AnswersIn as your main resource on a given topic? YES

- Subjects well covered in the resource

Would you use AnswersIn as your main resource on a given topic? NO

- Points came up too slowly
- Found books and Virtual Consultant better
- I use books but could try it and see how it works for me!

- The information is not really organised for “reference” use
- Too slow to find key information
- Would always use a textbook initially
- More comfortable using books as a main resource
- Would use it alongside books

How do you think AnswersIn could be changed to better meet your needs?

- more subjects covered
- More EMQ type questions
- More diverse subject matter
- other subjects/specialties
- A bit slow
- Sound does not work with RFH computers
- the interview format is a bit on the slow side- took a while to go through
- Wider scope with more specialties

Did the emails make you more likely to look at the AnswersIn website? YES

- I didn’t know some of the answers!
- Reminded me it was there
- yes but time constraints inhibited me
- reason why I looked at it in the first place

Did the emails make you more likely to look at the AnswersIn website? NO

- I usually rush through checking emails and do not sit for too long on the internet
- The stress of exams!
- personally, clinical cases in the hospital would encourage me to use the resource more
- Too near exams

Appendix L

Push Technology "Teaser" Content

Week 5

"You are sitting in clinic with a consultant gastroenterologist. The patient in front of him has been referred with dyspepsia and heartburn. The consultant turns to you and asks you:

"What is the difference between dyspepsia and heartburn?"

What is the answer?

Find out the answer to this commonly asked question at:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Introduction to dyspepsia" interview for a full answer

Week 6

You are on a ward round and come to a patient who is very thin with a nasogastric tube in situ. The registrar explains that the patient has severe refeeding syndrome. The Professor asks you:

"What do you understand by the term *refeeding syndrome*?"

What is your answer?

Find out how to spot this potentially fatal condition at:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Artifical nutrition- enteral & parenteral"" interview for a clear answer

Week 7

You are on take with the medical team and a patient is admitted with haematemesis and melaena from suspected oesophageal varices. The patient is unstable and the gastroenterology consultant advises the medical registrar to have the patient intubated and then to place a Sengstaken-Blakemore tube to control the bleeding.

The medical registrar asks you:

"What is a Sengstaken-Blakemore tube and how does it work? What other vital drug do I need to give the patient as well?"

Find out about this vital intervention at:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Haematemesis & melaena- variceal bleeding" interview for a perfect answer to this important question

Week 8

You are clerking a patient on the wards who has aggressive Crohn's disease. According to the patient she has been admitted for a strictureplasty but is worried because she doesn't understand what the procedure involves. She asks:

"I know I should wait to see one of the surgeons but can you tell me what a strictureplasty is?"

How will you answer her?

For the correct explanation of how this common procedure is carried out visit:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Crohn's disease- Surgery" section for an animated description of the procedure

Week 9

You are sitting in on a nurse-led gastroenterology clinic. The next patient has a new diagnosis of coeliac disease. The nurse-specialist asks you:

"What advice would you give the patient about dietary modification and the need for follow up investigations?"

How would you advise the patient if you were the nurse-specialist or doctor?

For a complete overview of the management of this very common and life-changing condition go to:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Malabsorption-Investigation & management of coeliac" section and you can advise the patient with confidence

Week 10

In an OSCE, the examiner is discussing a patient with severe ulcerative colitis. She asks you:

"What symptoms and signs might help me decide whether or not this patient should be admitted to hospital?"

What is your reply to the examiner?

For a complete answer to this vital question go to:

http://www.ucl.ac.uk/medicalschool/answersin/homepage.html

Access the "Ulcerative colitis- Assessing severity" interview for a full-marks answer.

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