Applying User Centred Design to Adaptive Web-based E-Learning
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Session (2001/2002)
Summary

1. Summary

The objectives of this project were to combine the three areas of User Centred Design, adaptivity and web-based e-learning, producing a set of guidelines detailing an effective e-learning tool can be realised. These guidelines are justified by conducting a study with the use of questionnaires released to a set of teachers and learners of a current e-learning site. A current e-learning site has been edited, with the implementation of the guidelines where possible.

2. Minimum requirements

This project was carried out over four phases, which formed the milestones:

- An appropriate survey of the three main terms given in the project (i.e. User Centred Design, adaptivity and e-learning) involving research from textbooks, journal articles and conference papers. This will provide sufficient background information for the following phases of the project.

- A set of guidelines will then be produced, based on the results gained from the survey. These guidelines will aim to aid the creation of an effective and adaptive web site to be used for e-learning.

- The guidelines will be verified by the issue of a questionnaire to a number of users of a current e-learning site. The sample of users will contain a representation of different levels of expertise on the subject, for example learners that use e-learning materials and teachers that develop e-learning materials. The purpose of this is to gain knowledge of the quality of learning and information provided by the site in question, and to determine the validity of the guidelines produced.

- The final phase of this project will involve the adaptation of the current e-learning site studied by the learners in the questionnaires.
I would like to thank anyone who has made any direct or indirect contribution to this project. In particular, I would like to thank my supervisor Vania Dimitrova, who has provided me with guidance and support throughout the duration of this project. I would also like to thank the teachers and students who took the time to complete the questionnaires, and the individuals who provided me with additional information regarding the project.

I would also like to thank my family and friends for their endless tolerance and support.
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1. Introduction

As an Information Systems student, the human aspect of computers has always been of more interest to me than the technical side. When I first encountered the concept of adaptivity, the idea that a person’s interaction with a system could be tailored to their individual needs seemed an exciting solution to the problems brought about by the design of generic material for every user. This is particularly important as the growth of the World Wide Web creates increasing opportunities for the dissemination of information. The idea of providing online learning tools also seemed highly advantageous to me, as they can be accessed anywhere in the world, and bring all of the benefits associated with the Internet, such as access to further information and collaborative working with other students.

In my studies I had already encountered system development and particularly “User Centred Information Systems Design” and found that the idea was of great interest to me, as there seems little point in creating a system without considering the people that the system is being created for. The aspects of this subject that involved the users of a proposed system participating in the design process seemed to be an extremely effective approach, as the problems brought by producing a system without determining who the system is for and what they would want from it are abundant.

The extension of the skills gained from this area of study has been achieved by the investigation of its applicability to new areas, namely adaptivity and web based e-learning.

User Centred Design(UCD) and adaptivity possess the same ultimate goal – to create a system that is as effective in delivering its information as possible, through the use of attempting to create the most appropriate interaction for the user. This project attempts to apply the theory of User Centred Design to the development of adaptive web based e-learning tools, in order to produce guidelines that could be employed to maximise the advantages brought by adaptive e-learning by involving the users in the design process. These guidelines will be verified by the completion of a study involving the potential users of an adaptive e-learning system, and a prototype will be produced, implementing the aspects of the guidelines that are possible within the constraints of this project.

The objectives of this project can be divided into two sections:

**Theoretical**

- To gain an understanding of the terms User Centred Design, adaptivity and web based e-learning, and to identify how the three areas can be related to produce an effective tool for learning.
To identify how theories on User Centred Design can be applied to the design of adaptive web based e-learning sites, by the creation of guidelines detailing how the design of such sites could be improved by the use of User Centred Design.

**Practical**
- To survey users of a current web based e-learning site, to gain their perspectives on which aspects of the site could be improved, and what contributes to an effective, adaptive web based e-learning site, in terms of providing the correct information, and accessing that information effectively.
- To study these results and implement the guidelines as much as feasible, to design and produce an improved version over the site studied.

The four phases identified in the minimum requirements form the milestones of this project – i.e. the completion of a survey of the terms; the application of the theory of UCD to adaptive e-learning and creation of the guidelines; the issue of the questionnaires and study of the results; and the alteration of the web site. They are ordered in this way due to the fact that the nature of the milestones necessitated that one could not be commenced until the previous was completed.

Appendix B shows the actual progression of the report, which was different to that predicted in the mid project report. The refinements to the details of the mid-project report (in particular, the minimum requirements and the objectives) were decided upon as it was realised that it would not be possible to carry out the iterative process that the full development of an e-learning tool would require. This was mainly due to an overestimation of what was possible in the time given, and a lack of appreciation of the need for such an approach and so the timescale was reviewed.

The overall aim of this project is to illustrate how User Centred Design can be implemented in the design of adaptive web based e-learning tools.
2. User-Centred Design

2.1 Introduction

Many Information Systems have been produced without prior involvement of its users, and have been found to be successful. However the involvement of users in the design and development of a system can improve its effectiveness at achieving its aims. In this chapter, the reasons for user involvement in the design of e-learning systems, and methods for its implementation, will be outlined.

2.2. Why should users be involved in systems design?

“Research shows that the more users are involved in systems development, the more satisfied they are with the delivered system, and the more they use it.” - Green (1992), in Vowler (1992)

The main aim in designing any kind of computer system is that it should be the most useful and effective that it can possibly be. One way to make this possible, is to involve users in system design. The needs of the user can then be effectively understood and addressed in the system.

Users hold a unique insight into the jobs that they perform, and it is required that the investigator “understand the ethos, customs and practices as well as the work process, its pressures and priorities” (Gough, 2001). This includes the culture of an organisation which can be defined as “the collection of relatively uniform and enduring beliefs, values, customs, traditions, and practices which are shared by an organisation’s members and which are transmitted from one generation of employees to the next” (Buchanan and Huczynski, 1997).

User input in design places a different perspective on the system, which will inevitably create new factors in the design, such as content and navigability issues. In this way, designers can exploit the user’s understanding of the task – how they go about obtaining information from a system and performing their jobs. In the design of any computer system, it must never be forgotten that the expert will go about using the system in a different way to the user, due to their increased knowledge of information technology and thus increased confidence. Therefore involving the users will result in an appropriate level of expertise employed by the system – for example with the use of computer jargon.

It is important to understand what is going on in the user’s mind when they are carrying out a task on a computer. Lewis and Mack (1982) discovered that a user may rectify an error as normal behaviour, devising explanations “which made the results of even disastrous errors seem reasonable”, and continuing with the task without rectifying these errors. If such a process was understood by the designers, the occurrence of undetected errors could be reduced when using a system. Users often comment that “I did it but I don’t know what I did”, and have short memories when transferring newly acquired skills between tasks. This can be rectified by active exploration of
the system by the users, however they may spend too much time in an irrelevant part of the system, which can be frustrating (Lewis 1986). The benefit of this approach (gaining familiarity with a system) can be transferred to being involved in the design process - the user can become familiar with the product as it is being designed, and change it to fit their needs, as opposed to attempting to master it after its implementation. Such an approach will increase understanding of the system, as “understanding facilitates learning, provides predictive and explanatory power, increases the likelihood that procedures will be remembered or can be regenerated, and enables the transfer of skills. In unfamiliar situations, understanding improves the efficiency, flexibility, and reliability of performance, permits and constrains generation of new procedures, and facilitates checking answers” (Riley 1986).

Involvement of users should provide them with an understanding of the final product, as well as the methods employed producing a system. Franklin (1996) believes that involving users “achieves compatibility between the social and technical systems design”. The Institute of Personnel Development (1998) states that “the more satisfied workers are with their jobs, the better the company is likely to perform, in terms of profitability and particularly productivity”.

Users may appreciate involvement in the design of a system, after previous experience of non-involvement resulted in the production of an inadequate system. It must also not be forgotten that there are “as many perspectives on change as people” who will use the system (Willcocks and Mason 1987) – this means that effective communication lines must be established, in order to dispel any fears over job security, job changes and power and influence (as “knowledge is power”).

Ostwald (1996) sees information systems development as an “opportunity to redesign traditional work practices, creating new relations between workers, their computational tools and their tasks” . The “Evolving Artifact Approach” requires user involvement in order to fulfil this objective, because the knowledge required cannot be gained through traditional requirements gathering methods (interviews, observations etc.), and requires a “social and evolutionary process” , involving all stakeholders.

Alexander(2000) states that “problems associated with…interfaces are too often wrongly attributed to user incompetence…Poor design is the result of insufficient focus on the users of web sites” . This paper states the importance of ascertaining a number of factors about your target audience:

- **Technological capabilities** – what kinds of computers and web browsers are used. This may be possible through surveying current users.
- **Physical capacities** – if the users are likely to be visually impaired, have a colour deficiency, a hearing impairment or have reduced motor skills, this must be taken into account.
• **Cultural context** needs to be taken into account – if the intended audience is global, the use of culturally-specific humour, colloquialisms, icons and abbreviations should be avoided.

• **Motivations** for visiting the site can determine the top-level information of the site, to attempt to retain the user.

• **User habits** can determine the functionality of a site – for example do users prefer to navigate a site, or use a search facility?

• **User preferences** can be taken into account – e.g. would be users be aware of the possibility of, and be likely to, disable JavaScript, cookies etc.

Alexander also states the resulting site will be one that users find *pleasant* to use, and so they will **return**, which enhances the **reputation** of an organisation. The importance of such an approach in web site evaluation is also stated – from the users’ point of view, it can be determined as to whether it provides useful **content**, a good **service** (better than competitors), and generally provides the best alternative to gain the required information. From the organisation’s point of view, how far the site has met its **objectives**, how much the organisation’s reputation has been enhanced, how well its service has been improved, or whether its costs have been reduced, can be considered. This is made possible by user involvement because “users cannot evaluate a site’s content or delivery of services if they cannot use the site” . Alexander finished by stating the eight design principles of user-centred design: “**know your users; make things obvious; aim for a simple, clean design; be consistent; use existing standards** (e.g. URLs in blue font, and underlined), **provide feedback, facilitate user control and freedom** (to customise the site); **and design to prevent errors and aid recovery** ”. The article closes with “the web is a user-empowering environment, but only in theory. A user-centred approach to design will give power and control back to users.”

### 2.3 Why should users NOT be involved in systems design?

Smith (2001) pinpoints four reasons for avoiding user-centred design.

• Users can advocate the use of technology for its own sake – they can be “distracted from the task at hand by the cleverness and novelty of our technologies”, by focussing on what technology can do, rather than **what simply needs to be done**.

• User centred approach does not often produce the “sexiest” option - designers tend to prefer to use attention grabbing technologies, such as Flash ¹, while sometimes, the most user-friendly option is a more **subtle** approach.

• Difficulties are inherent in user centred design, stating that some people do not possess the skill needed to understand their users. Smith identifies a trade-off between skilled programmers and

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¹ “Flash, a popular authoring software developed by Macromedia, is used to create animation programs with full-screen navigation interfaces, graphic illustrations, and simple interactivity in an antialiased, resizable file format that is small enough to stream across a normal modem connection.” – http://whatis.techtarget.com
those familiar with **what a good interface should be**, and recommends the presence of a “**user advocate**” within the design team, to ensure that the product performs the required tasks in an “**appropriate way for the intended customer**”.

- His final point is that the user-centred attitude is hard to teach, and that it requires a combination of a “**desire to make people’s lives easier and happier**” and an awareness of the most appropriate solution to satisfy those requirements.

Moynihan (1989) argues **against user involvement** and states a number of what he believes to be “**obvious problems**” with it. He points out that the users may not be **easily identifiable** (for example, with a new product), or that the user population may be too great, and may change too much over the development period. He also states that the users may not know all of the details of the tasks that they perform, as many have previously assumed. They may also not **understand the potential** of the technology involved when composing the system specification, and so the best solution may not result from user involvement if the user is given too much responsibility. The users may also not have the **time** to devote to involvement. He believes that it is assumed that users will be impartial and not obstruct the project, but may try to **influence the analyst** to draw conclusions which are favourable to them – this may stem from an incorrect perception of the system. He also points out that users may not be comfortable with authorising the details of what may be an **expensive, complicated and important** project. He questions the **competency and decisiveness of both users and analysts**.

He proposes that a userless solution can still be effective with the use of **“user surrogates”**, **documentation** from previous systems, internal documentation, external information (e.g. government publications, business textbooks and journals and hardware and software suppliers) and by consulting with professional associates with experience in system design.

The accuracy and relevance of such opinions be questioned – the analysts may become **buried in too many sources** when the **focus** should actually be on designing the system. It would appear to be nonsensical to design a system with no knowledge of those who will use it, and the statement that users will be transient cannot apply to **all users**. It should also be noted that analysts are not impartial either, and obstruction may result from a lack of user involvement rather than be caused by it. The users **should** be encouraged to influence the analyst to see the potential solution from the user’s viewpoint. Moynihan makes a **final statement** – that users **and** analysts can be incompetent and indecisive. This illustrates that his view of systems analysis is **extremely pessimistic** and if neither party to the process is **capable** of the development, any project is surely **doomed**.

Smith’s first point – that users may want technology for its own sake – is a valid one. The designers will have to **verify** that any decisions made by the teachers on the design of the site are technically sound. Smith’s statement that designers prefer the “**sexiest**” options may seem **contradictory**, but this emphasises that the designers and teachers **may disagree over issues**. If both parties think that
different factors are important then agreement must be achieved, or this will seriously impede the progression of the project.

Moynihan’s first statement is especially applicable to e-learning as it is very likely that learners will not be easily identifiable. This is particularly applicable if the proposed site is a general educational site – i.e. not targeted at a specific group of users. In this case, the user population is probably very vast, as the site would be accessible from all over the world, and so anyone wishing to learn about the subject would be a potential user. Obviously all users could not be involved, but this would probably not be necessary anyway. The designers could gain information from the kind of user that the site would attract (i.e. not necessarily prospective users of this site), for example if registered on a similar site. If the site is to be a supplement to an existing university course, attendance lists for example from pre-requisite modules, could be used to find learners. The teachers are easily identifiable, as they are the people who brought about the project, and may be able to provide the designers with information about the users, such as the kind of experience with computers they might have and the goals that they posses. It is possible that the user population may change over the development period, for example if students were undertaking a degree course, they may have completed the relevant module when the site is completed. However the information that they provided could be applied to other students. For example, if a group of second year Information Systems students were studied, they would probably have a similar level of competence in navigating web pages, and would probably have similar goals from using the site – i.e. to pass a second year degree standard module.

Moynihan takes an extreme view. Despite the fact that he does raise some valid points, he also condemns the majority of projects to failure and does not acknowledge the increasing number of developers who strive for effective user involvement (Gough 2001).

2.4 How can users be involved in systems design?

Damadoran et al (1980) stated the different degrees to which the user can be involved in the design process:

• No user involvement could be employed because it is perceived that the project team already contains the necessary expertise required to produce the best system possible, i.e. that an improved system, would not be produced with the involvement of the users. In some cases it is thought that user involvement would be detrimental to the project, as it would not produce any benefits, and would consume time and resources.

• One way involvement simply involves “Communication, consultation and training”, which could be effective in the event of a successful system. All three mechanisms are under the complete control of the project team and so user response is limited. Therefore from the designers point
of view, this method is “relatively safe and straightforward to conduct” however if a user had serious doubts over a decision, “these techniques are unlikely to allow these doubts to be heard”.  

- **User representatives** – this can be organised into two areas. The project team could contain user representatives to advise the designers during the development – this has the advantage of readily available user expertise, increased manpower and can form a basis for post-implementation liaison. However the users may become less representative as they fall under the influence of the specialists, and they may cease to consult their fellow end-users when making important decisions. They may also be unable to handle the conflicting demands of their dual roles, and they may not understand the jargon used in system development.

Users can also form consultative committees to challenge decisions made by the designers, however it is important that these groups hold the appropriate degree of control over the design team. It is also important that they are an acceptable representation of the various interest groups – that the members properly consult their “constituents” when making decisions.

- **Participative design** involves all users selecting the allocation of tasks between man and machine. However, the experts may play a minor role in the early stages, which can result in the production of a specification that is technically difficult to bring to fruition with the expectations of the end users already raised. It is also difficult to manage a large volume of users.

- An approach of “Users design, experts advise”, means that control over, and responsibility for the system rests solely with the users, and the specialists ensure that the solution is technically viable before they implement it. This solution is often effective because of the users’ knowledge of their jobs and office cultures, and the fact that the users need to maintain the system after its implementation, but again presents the same problem as the previous level.

Peppard and Rowland (1995) recognise that change (brought on by the introduction of a new system of working) may initially be resisted by the users, because they are content with the “status quo”, they do not understand why change is required or they do not have faith that the company can successfully conduct this change. The kind of changes to be considered in an organisational environment would be changes in work practices and methods. In the implementation of a web based e-training site, this would involve a change in teaching styles and methods. For example some university lecturers may think that there is nothing wrong with the traditional method of lecturing students and telling them to go away and read a book. If these feelings still exist, they can be dispelled by following the recommended procedure of :-

- Building a vision or setting targets for the future, and communicating this information to ensure the users are aware of the improvements that the new system will bring.

- In a commercial situation, the support of management must be gained.
• Formulating a **plan** of how the system development will take place: this will include milestones, communication channels (the subject of redundancies should be quickly addressed) and preliminary training should be commenced as quickly as possible to “boost confidence”.

• The appropriate levels of management should identify the **core processes of the organisation** to “provide a framework for the re-engineering effort”.

• The appointment of a “**team champion**” – someone in which the board have confidence, as part of a team of 4-12 influential members of key departments.

• Details of the above need to be communicated to everyone involved in the development so that everyone is informed of the situation through official means and not the “**grapevine**”.

The aim of the above is to give prospective users a **convincing argument** for change, identify who will be affected and illustrate the benefits to individuals and the organisation.

**2.5 The users of an e-learning site**

The first step to be taken in designing a system is to identify the users of that system. In an e-learning system, there are two categories of user – the **learner** and the **teacher**.

The learner is using the system to **gain some form of knowledge from it**, and uses it as opposed to traditional learning methods, as the information **may be easier to learn**, and the **volume of information** available will be greater, and **easier to access**. The material will be **more convenient** to access, as it can be viewed whenever the user wishes, and does not have the limitations associated with attending a 9.00 lecture, as the only way to obtain the required knowledge. This would also mean that they did not have to travel anywhere – this factor also has implications for those learners who are geographically too far from the information source (e.g. to attend a university course).

The teacher may invoke the setting up of an e-learning site, for a number of reasons. The **motivation** for any teacher to enter their profession, is to provide students with the knowledge on a given subject (i.e. to teach), and the use of an e-learning site aids the pursuit of the goal to teach people. The teacher can provide information for the learner so that **all course material** is readily available, to improve their learning experience. They can reach a wider audience and so their **knowledge is spread to more learners**. They can also take advantage of the **computational power** provided by the use of an e-learning system – **online tests** can be conducted and marked quickly, and **feedback** can be given to users. The site can also provide a forum for students to ask questions.
2.6 Why involve users in the design of an e-learning site?

In previous sections the arguments for and against involving users in systems design have been outlined, and the requirements for employing user-centred design have been summarised. This section will relate these issues to the design of web based e-learning materials.

As with the development of any kind of computer system – in order to produce the best and most effective web site possible, the designer must have a comprehensive knowledge of the site’s prospective users, so that the content and navigational features can be designed accordingly. Therefore all theories on systems design can be applied to the design of web based e-learning sites. If the site would be used within an organisation (for example to train staff for a new software package, method of working etc), the details of the inner workings of the organisation would need to be known. The designers can benefit from the input of the user as this will raise a different perspective of the site and keep the designers on a similar level to the users with respect to complexity and jargon. The users will accept the site more if they were involved in its design – they will be able to understand its features and why functions perform in a certain way, as well as appreciate the full benefits of the site, as they will be aware of features that may have previously lay undiscovered.

As users, teachers are required to provide the content for the site – they can place the information that they want to provide onto the site, and ensure that it meets any requirements (i.e. syllabus requirements). As users of their aspect of the site (i.e. editing content and assessing students), they can provide information on what they would like to have in the site, and how they would navigate it. They can also advise the designers of the site in dealing with the diversity of different students, when designing the material.

In the design of e-learning sites, the nature of such a system means that a comprehensive knowledge of the users is critical. Due to the vast amount of information that is available on the World Wide Web, it is important that the learner can access this information. Despite the promise of information, if a web site is difficult to use the users can be left disillusioned and lacking the service that should have been provided for them. In “The Design of Everyday Things”, Norman states that during design, “if an error is possible, someone will make it. The designer must assume that all possible errors will occur and design so as to minimise the chance of the error in the first place, or its effects once it gets made.” In an e-learning site, if a user was to miss a link (because it was not displayed in the appropriate way) this would constitute as an error. The input of both kinds of user would hopefully have the result that the way to obtain all of the necessary information is made abundantly clear.
User-involvement in the design of a “virtual school” proved invaluable to the LiNC (Learning in Networked Communities) project (Carroll et al 2000). As well as being able to share their knowledge of “pedagogical goals and practices, classroom management, school system politics, [and] the relationship of community and the schools”, the four-year process proved to be “fundamentally a process of mutual learning and thus of professional development” for the teachers. The teachers went through four phases of participation: as a “practitioner-informant” (“bridging the communication gap between classroom expertise and software development expertise”), “analyst” (making sense of the activities performed in a classroom in the context of a computer system), “designer” (suggesting solutions as opposed to “articulating the problem”) and “coach” (teaching others about the system, and “inspiring colleagues”). As the project progressed, evidence of a feeling of ownership by the participants increased, which enhances the quality of the system, as well as the acceptance of it.

If the learners of an e-learning site are familiar with how to use it, they will be more open to actually learning from it when they begin to use it, as opposed to concentrating on learning how to use the site. This can also apply to the teachers, as they may spend time familiarising themselves with such things as editing facilities if they were not involved in their creation. The teachers would also be more comfortable with the content of the site if they had total control over it.

2.7 How can the users be involved in the design of an e-learning site?

The study by Damodoran et al (1980) can be applied to web-based learning systems:

- **User representatives.** The two kinds of users in an e-learning environment would have different roles to play in this case. The teachers would have instigated the process of creating the site, and so would be involved from the very beginning. They could also provide learners to approach as they may be registered on a module that they teach. They would provide the information that the designer would require – specifically the knowledge required. The designers would need to know if assessment methods were required and if they would be in conjunction with, for example, lectures. If the teachers wanted to monitor the students’ access to the site (for assessment purposes) they would need to inform the designers to create such a facility.

The project team could contain learner representatives to advise the designers during the development. Locating such users can occur by studying a student’s motivation for visiting an e-learning site – if it is compulsory, this means that there is identifiable user group, for example those registered for a university module. Such users could be selected randomly from user lists. Participation could be in the form of a questionnaire and could also be provided for users who would use the site to for learning over a long distance.

- **Participative** design would involve each individual user of the proposed site – or as many as was possible. In studies such as the LiNC project this would be a complex, long-term...
mechanism, however the benefits of such a theory can be gained, by embarking upon a smaller scale study, by all users being e-mailed questionnaires. This would be a fast way to gain information, and the most convenient, given the possibility that this would involve a high volume of recipients and thus a high volume of information to be taken into account when designing the site. Hopefully an appropriate cross section of the users would be gained, however a low response rate can probably be expected. This would be more practical in a case involving accessing the information over long distances.

Katz-Haas (1998) has proposed six stages to developing User-centred web sites:

- **Involve users from the beginning** – by understanding their expectations, involving them in the design process, observation and feedback in both directions. It is not enough to make a site usable, but to “discover how your particular users interact with this particular site”. It is more feasible to employ the teachers from the commencement of the project, as they are guaranteed to be available throughout, as they have instigated the development. However, the learners must also be involved early on, in order to understand their characteristics, preferences and goals, in order to produce the requirements of the system.

- **Know your users** by asking them their level of experience with: computers, the web, and the subject of the site, as well as discovering their working environments; hardware, software and browsers; their preferred working styles; language; cultural issues; any training that will be received to use this site; and their needs and expectations of the site. This is important in e.g. as learners may come from a variety of backgrounds, with different levels of computer expertise. This will aid the designers in deciding what level of technical terms can be used and the levels of information to be provided.

- **Analysing user tasks and goals** through observation and interaction, to ascertain: what tasks are performed, and how; why tasks are currently performed the way they are; what information the user requires; how the users discover and correct errors; and what their ultimate goals are. The learners’ goals will contribute to the level and kind of information provided. For example, a learner may only seek a basic level of information, and so providing information that is to a degree standard, may be too difficult for the learner to understand. The level of information required if an organisation is implementing a project involving user centred design, and an employee wishes to familiarise themselves with the concept would differ, compared with a university student seeking information for a final year module, basic information will not be sufficient. What the teachers expect from the system will contribute to its design. In particular, the tasks that the teachers expect to be able to do in the system, such as assessment and page editing, will be considered when designing the functionality if the system. The preferences of both sets of users will need to be accounted for – this includes whether they prefer to be in control (i.e.
use query facilities) or be guided (with browse facilities), and what they think is useful, effective and efficient in a web site (Cato 2001).

- Explore **different designs** and illicit user feedback on each of them, before making final decisions on **direction, development and design**. Both the teachers and the learners can examine different proposals in person, and identify positive and negative aspects. The learners may be apprehensive to devote much time, without incentive (as the site **may be of no use to them** when it is launched). Distance learners could be **emailed details of proposals**, e.g. screen shots, proposed features, but they would also be apprehensive to devote a great deal of time.

- Ensure that usability testing is an **iterative** process. Once modifications have been made, they **must be tested again**, as this is **the “only way you can know if this particular site meets these users needs”**. This is possible if the users are willing to be involved (see above) but as the iterations continue, a lot of time and patience would be required.

- As well as usability testing, **research** must also be carried out **in “Cognitive Psychology, Anthropology, Human-Computer Interaction, Visual and Graphic Arts, Communication, User Interface Theory, Linguistics, Human Factors, Information Design, Instructional Design, Colour Theory, typography and more”**, to ensure **fully effective** User-Centred Design. This information may be possessed by the designers, but research would probably be required by the designers and teachers in particular, as if they understand the reasons for the existence and appearance of some features, they will prove easier to use.

INUSE 6.2, also provides guidelines to follow in order to achieve effective User-Centred Design. They are based on the recommended principles of ISO 13407 and are comprised of four phases:

i) **Understand and specify the context of use for the proposed system** – this is important in order to design the correct system, and provide a basis for evaluation. Specifically, this information can be categorised into three areas:

a) **The characteristics of the end-users** – this includes the users’ **“knowledge, skill, experience, education, training, physical attributes, habits and motor-sensory capabilities”**. This ensures that the system is built to the correct degree of ability.

b) **What tasks the users will perform** on the new system – this includes the nature of the tasks, the role of the system within these tasks and the frequency and duration of these tasks.

c) **The environment of the organisation** – organisational factors (the level of autonomy of the staff), technical factors (the hardware that the new system will operate on) and physical factors (office layout, heating and ventilation, noise and health and safety).

Such information is obtained via **interviews, observation** and **questionnaires**, but more commonly by **“brainstorming”** sessions, and recorded in a document that should be shared with each stakeholder, and that can be updated whenever the context of the system should change.
Such techniques would be plausible when involving the teachers, as they would be available to gain information from, however as explained above, learners may be remote and could only be approached via the use of questionnaires as they are likely to be approached remotely.

ii) **The user and organisational requirements for the system must then be specified** – this is “widely accepted as the most crucial part of software development” and includes the **technical**, **functional** and **usability requirements**. The specification should:

a) Identify the **relevant users** of the proposed system, and other personnel involved in the design.

b) Provide clear **design goals**.

c) **Prioritise** each requirement.

d) Provide **measurable benchmarks** to judge progress by.

e) Provide evidence that the requirements have been **accepted by the stakeholders**.

f) Acknowledge any **statutory or legislative requirements** (such as syllabus requirements) that may arise from the system.

Again, teachers would probably be able to provide such information, and formulate benchmarks, but learners can also provide the information to formulate design goals.

It is important to be aware that these requirements may change over time. The teachers can also provide information on any other personnel that would be involved in the system, but may not use it, such as external examiners, or those financing the project.

iii) **Designs and prototypes of the system must be produced** as this allows the designers to explore **many design solutions** without **incurred the cost** that would arise if a system was to be produced and then found to be inadequate. The prototypes should be presented to a **representative sample of users**, and as the project progresses, the mock-ups will **increase in complexity** from basic materials such as paper, card and pencils, to computerised interactive simulations. Analysing prototypes also fosters greater communication between the development team and the end users. This is more likely to involve the designers of the system, but users may be involved if they possess the required expertise.

iv) **The system or prototype must then be assessed by the users**. This will confirm how far the objectives have been met, and provide suggestions for modification. This must be carried out as early as possible, as changes may become **more expensive as the project progresses**. Prototypes can be assessed by teachers and learners in person or remotely, depending on the circumstances. Different prototypes would be produced, for the different areas of the system. For example, the teachers would assess the editing and assessment features of the system, whereas learners would assess the prototypes concerned with accessing the information to be learnt.
a) Evaluation must be planned – i.e. who will evaluate the prototypes, what tools and methods are involved for obtaining and analysing results, and what timescale is involved. The teachers and the users who were on hand, would have more input into this plan than the remote learners, as the communication would not be as active.

b) The data should then be collected and analysed which will generate feedback on usability. Users may notice something that the designers did not (or feel that something is more important than the designers had anticipated). The teachers and non-remote learners could have input into the analysis of results, however this is likely to be conducted more by the designers, as they will be more experienced in interpreting the results.

c) An evaluation report is the produced, containing recommendations for change. This report confirms that the results are valid, that a representative group of users took part and that the system was tested in sufficient detail, and details of the evaluation and analysis procedure. Overall this report would indicate whether the requirements and objectives had been satisfied. Both users and designers would have input into this document, and all points of view must be considered.

d) This phase would be iterated many times due to the ease and relative low cost of it. As the iterations progress, the number of test users will increase, the complexity of the tasks used to test the system will grow, the formality of the test procedure will increase and the prototype will become more sophisticated. As system becomes closer to the intended final product, the site could be uploaded and tested by most if not all known users. Adequate records must be kept to record the changes between the iterations.

e) Continued usability input is required beyond the implementation of the final product – this is to ensure that the system is constantly improving, and meeting changing usability requirements. This could be achieved with a feedback facility in the e-learning site, and is where the learner population could be used most, as the users will identify themselves by using the system – especially distance learners, who were previously unknown. This aspect should also be recorded.

Chin, Rosson and Carroll (1997) and Carroll et al (2000) took user involvement a step further from that of simply providing information, to analysing factors in their use of a system. This resulted in “mutual learning between user and designer, application of design tools familiar to users, envisionment of future work situations, and grounding of analysis in the practice of the user” (Chin, Rosson and Carroll, 1997).

2.8 Conclusions, and their implications for this project

In the design of any kind of information system, those involved will strive for the best quality possible, and the best level of acceptance from the user. One way that this can be achieved is through the involvement of the prospective users of the system. This ensures that the users requirements are
clearly identified (their capabilities, motivations, habits, preferences and the context of the system), and that they understand the final product, so that they can use it effectively. It must never be forgotten that the system is being designed and implemented for use by the users, and their involvement throughout the entire development process will remind the designers of this.

Disadvantages of involving the users do exist, however they can be overcome with an awareness of them, and effort to avoid the problems — this may be achieved by compromise between the users and the designers, and more detailed discussion of possibilities when disagreement occurs.

In the context of e-learning, the two types of users can make different contributions to the design process. The learners can advise the designers of their abilities, level of knowledge, goals and preference, which can be catered for when designing the interface and content. The teachers can provide similar requirements for their interaction with the system — when devising online assessment methods and facilities to edit the content. They can also provide further information to the designers, for the design of the system for the learners — specifically the content of the site and possibly some characteristics of the learners that could be expected.

There are a number of methods that can be employed when involving the users, each of which involve different levels of involvement and are subject to constraints, for example distance and convenience. With a project in which the users are not remote, it is easier to employ brainstorming sessions, and involve the users in design committees and testing mechanisms. The teachers involved in an e-learning site are likely to be available for this kind of involvement and will be motivated to do so, as the success of the site is in their best interests. The availability of the users in such a case is questionable, as they may be geographically distant from the project, and so would be difficult to identify, and only be able to participate via email (for example with the use of questionnaires). Even if they were able to take part in such mechanisms, their motivation to do so would be questionable, as they may see no benefits to be gained for themselves.

It is crucial that the requirements for the system from the point of view of both types of users are fully understood, and so the utmost effort should be applied if detailed requirements are to be sought.

In the context of this project, the potential users of a User Centred Web Design tutorial will be consulted, in order to ascertain requirements. Due to the time-scale involved, and the improbability of user participation beyond the completion of a questionnaire, the employment of such methods proposed by Damodaran and Katz-Haas would be beyond the scope of this project (this includes an iterative approach). The use of questionnaires will therefore attempt to gain the information that is required.
3. Adaptive E-learning

3.1 Introduction

The growth of the World Wide Web has provided a medium for the exchange of information over a long distance in a short amount of time. An area that this has proved beneficial for is education, and a number of systems have been developed to take advantage of the opportunity to provide and gain information, from all over the world. The increased computational power that is now available has also allowed the implementation of adaptivity in these systems. The features of such adaptive e-learning materials, and examples of which, are detailed in this chapter.

3.2 Definitions

This section aims to clarify some terms often used in the context of adaptive systems.

If something is adaptive, it is dynamically “changed to fit changed circumstances” – i.e. by the system. (WordNet 2002), as opposed to being personalised by the user. Jameson (1999) defines a user-adaptive system as a system which “adapts its behaviour to the individual user, on the basis of non-trivial inferences from information about the user”. Brusilovsky (2000) defines Adaptive Hypermedia as the opposite of “static…one-size-fits-all” in that it changes to fit the individual user's perceived “goals, preferences and knowledge”, and that an adaptive system will “personalise” content, according to this profile. Fink and Kobsa (2000) state that “personalisation is used as a generic term that denotes user-adaptive system features and user modelling issues as well”.

Any differences between personalisation and adaptivity will not be examined, instead, for the purposes of this project, the terms will be used interchangeably (as suggested by Fink and Kobsa, 2000), to mean a dynamic alteration by the system, according to the perceived needs of the user.

3.3 Introduction to adaptive systems

Jameson (1999) details the advantages of adaptive systems over static ones – in each case, a criteria is required to be input by the user, and the information provided is adapted based on that. This can be used to adapt the way information is presented, recommend products or other objects, aid the user with information retrieval, enhance learning, utilise help sections more efficiently, adapt an interface, carry out routine tasks and support collaboration.

Using adaptive systems aids the above, as they save the user searching through a high volume of information; the search is performed quickly; the frustration felt by the user is reduced; and information that the user is interested in is provided, and in a manner that the user prefers.

This aid to the user takes place with the use of “plan recognition” - a feature of some adaptive systems, which attempts to identify the users goals before they have been explicitly defined. These
goals are inferred by the information that is already given to the system, using heuristic analysis aiding the user’s interaction with the system (Carberry, 2000).

Stephandis (2001) states that adaptive systems possess the ability to select between different interaction and presentation characteristics, from those built into the system, as well as the ability to identify the circumstances that require adaptation, and to “select and effect the appropriate course of action”. He also states that adaptive techniques permit “universal access” (“coping with diversity in the target user population…..the scope and nature of tasks and the technological platforms”). This contributes to the realisation of the “fundamental” objective of HCI (Fischer 2001) - to maximise the interaction between user and computer. He identifies that the problem with non-adaptive systems, is that assumptions must be made about the user’s “specific background knowledge and objectives”.

3.4 Adaptive e-learning

Adaptive e-learning employs the use of adaptivity to aid education – this permits global access to the teaching materials, and any other relevant information regarding the course – e.g. by the use of web links. E-learning permits “open learning” – where learners exercise control over how, where, when and at what pace learning takes place (Race 1998), as it does not follow the structure of traditional teaching methods – i.e. a class being set at a specific time and place. “Distance learning” is a form of open learning “which takes place at a distance from the provider” (Race 1998). Computational power can also aid the assessment of students’ work by processing large amounts of data e.g. online multiple choice tests, and allow multimedia technology can be employed, incorporating text, graphics and sound, to aid learning. In an educational context, the use of adaptive systems can be very beneficial, as they tailor the teaching material in accordance to the student’s previous experience and knowledge of the subject. This information is gained by the user completing online tests, or a form detailing their current knowledge.

Stern (1997) cites that research has found that such educational tools teach “twice as quickly as traditional classroom methods, and produce increased skill retention with fewer mistakes”. She also states that adaptive e-learning systems increase motivation, by providing “individualised instruction”. She highlights the role of simulation in such systems (learning is permitted when, without simulation, it may otherwise not be). Pidd (2001) states that simulation reduces cost, saves time, permits replication and reduces safety or legal factors.

However, such techniques can be difficult to implement - Dovgiallo (1997) points out that the system does not know how the user came to view a document. A solution to this problem is the use of a registration mechanism combined with CGI (common gateway interface) forms, which produce dynamic responses to user input. User input can be related to previous input, and decisions can be made by the system about adaptivity. The CGI forms permit various assessment facilities, including
true or false questions (radio buttons), multiple choice and short answer questions. Each attempt is evaluated by the CGI program, which then produces an HTML document containing the results and any online help that is recommended. All test results are stored in a database, and the CGI program generates a new version of the test for the next user.

### 3.5 Examples of adaptive e-learning systems

This section aims to illustrate practical application of adaptive e-learning, and the features of such systems.

#### 3.5.1 ITLS

The Intelligent Language Tutoring System (ILTS - Heift and Nicholson 2001) is designed for students of German and developed specifically for distance learning. The users complete exercises online, and the system analyses this input from the user. It calculates a score for such areas as grammar, vocabulary and punctuation and then tailors the follow-up exercises according to the student’s weaknesses, as illustrated by their performance. The feedback is also filtered to incorporate the student’s level of expertise in the language, and their native language (inferred by answers already given). Student records are kept in a database invoked via a login process and a performance history is created and stored. This system is universal, in that users are not excluded due to their native language or level of ability – any student with internet access wishing to practice German can use it.

#### 3.5.2 NetCoach

Weber et al (2001) devised the NetCoach which teaches web site authors, without the knowledge required to program complex user modelling facilities, how to develop adaptive sites. It provides the user with “curriculum sequencing” presenting the user with “the most suitable, individually planned sequence of knowledge units to learn and the sequence of learning tasks (examples, questions, problems etc) to work with”, finding the user the “optimal path” through the material. “Adaptive annotation of links” changes the appearance of visible links to aid navigation. Such techniques require a content-specific knowledge-base and user modelling, to respond to each user’s needs individually. Users can also adapt the presentation, annotation and feedback themselves.

#### 3.5.3 Multimedia Asynchronous Networked Individualised Courseware

The MANIC system is a “shell for Web-based intelligent tutors” (Stern 1997) and allows students to see the HTML slides and hear the audio from lecture based courses. The completion of a “pretest” by the student creates a low-level model of that student’s ability. The system considers a student’s knowledge as a subset of the expert’s – the ultimate aim being for the student to have knowledge that is equivalent to that of the expert. This model is then enhanced in five areas as the tutorial begins:
• **How much** of the topic the student has viewed, according to how long is spent on each page – this can be inaccurate, as the student may be doing other things while still being on that page.

• **The version** of information selected: if a more advanced version is selected, it is assumed that the student possesses a more advanced knowledge.

• The student’s **access patterns** for the pages – if they choose to review more pages on a certain topic, this shows that their understanding must be enhanced.

• Whether the student **follows any of the hyperlinks** provided – which also shows that they require further information to cement their learning.

• The **completion of a quiz** on the material provided – if the student performs well in this, this is compared to the other areas and added to the student model.

The MANIC system also tracks **how the student’s performance changes over time**. When a student completes a topic, they can either **select** their next topic from a list provided, or can proceed to the topic that is **recommended** for them by the MANIC system.

### 3.5.4 A Web-based Authoring Tool for Algebra-Related ITS

Virvou & Moundridou (2000)’s system (in Kosba 2001) analyses student exercises and diagnoses student error, adapting navigation to suit the student. The student’s **supervisor can also assign the order** to which the student receives the exercises, and the difficulty level. This system has four components:

• The “**domain and problem generator**” accepts **input from the supervisor**, which describes the problem. This information is stored in a database.

• The “**problem solver**” component interacts with the user as they are solving the problems that have been presented to them by the system.

• The “**student model**” contains the information **deduced from the previous interactions**, and is also based on their overall intelligence and ability at solving algebraic problems.

• The “**error diagnoser**” finds the **cause of the student’s mistakes** and provides the appropriate feedback to both the student and the supervisor, through the “**Student Advice Generator**” and “**Instructor Advice Generator**”.

### 3.5.5 InterBook

Brusilovsky et al (1997) developed a tool to **write and deliver adaptive textbooks** on the World Wide Web, with **user knowledge tracking**, and **adaptive navigation support**. The user model stores **any** data that could be used to aid learning, by tracking user actions such as the length of time taken to read a page, the route taken through links and the solving of multiple choice exercises. This user model is employed to a **dapt interaction techniques** such as link annotation, “**prerequisite-based**
help” and ordering of tasks. Kosba (2001) states that “using these adaptive techniques, InterBook is able to build an unlimited number of personalised adaptive courses from the same course material”.

3.5.6 PAT OnLine

Brusilovsky et al (1997) also devised a way to facilitate co-operation between InterBook and PAT OnLine, as InterBook delivers conceptual information and PAT OnLine provides interactive problem solving facilities. Such an interaction would be beneficial in teaching such subjects as high school algebra, as the student can learn the theory and then put it into practice. The student models are shared between systems, via a “Communicating Peers” architecture, involving the two systems exchanging information about a user profile with the use of special protocols. The interaction between InterBook and PAT OnLine was influenced by two design goals. Both systems must function with sufficient independence – i.e. it cannot be assumed that students have access to both systems. The communication protocol must also be sufficiently generic to permit communication between the two systems and external environments. In terms of the adaptability of PAT OnLine itself, it operates in the same way as InterBook, by building the student model based on information gained from student interaction, and adapting the material and presentation accordingly.

3.5.7 ELM-ART II

This was devised by Weber & Sprecht (1997) (in Kosba 2001) to aid learning in the programming language LISP. It employs the traffic-light metaphor to inform users as to whether they should view a page – a green circle means that the page is suggested to be visited, and a red means that some of the prerequisite concepts are not yet familiar to the user. In the case of a test question, a yellow ball denotes that the task has been completed successfully, whereas if used for a page, this means that the page has already been visited. In the case of a terminal page, an orange ball denotes that the system has inferred that the student need not visit this page after successful completion of other areas. In the case of a lesson or section, an orange ball indicates that the page has already been visited, but not all areas have been examined, and not all links have been followed. The ELM-ARTII system can predict the way in which a student will solve a problem and find the most relevant example, feedback and help messages to complement this. Code produced by the student is “cognitively diagnosed in terms of domain knowledge” in order to ascertain their characteristics, and build the student model.

3.5.8 AVANTI

Stephanidis et al 1998 aimed to “address the interaction requirements of individuals with diverse abilities, skills, requirements and preferences (including disabled and elderly people), using web-based multimedia applications and services”. This system supported context-level adaptation, by constructing adapted hypermedia documents for each individual user, based on assumptions about
user characteristics, held in the User Model Survey. User characteristics that are observed are the type of disability and expertise and interests of the user, and the adaptive features are presentation with different media (e.g. text vs. graphics), additional functionality (e.g. shortcuts), different structure and different levels of detail. The system can also be adapted by the user, to include bookmarks, aids for motor-impaired users (e.g. text completion) and assistance in task completion.

3.5.9 NASA’s C Language Integrated Production System

The CLIPS system was implemented on the World Wide Web to reduce training costs, and proved particularly useful for troops in remote or inaccessible locations. This system employs a student profile and adapts the material presented accordingly. This system is unique due to its security requirements – significant decisions are made based on performance, so cheating and sabotage must be prevented at all costs. Therefore students cannot access information regarding their, or other people’s, profiles. Goldstein (1997) also points out that such a system cannot be used to its full potential, as they are often very bandwidth intensive, and such systems are expensive to implement, in terms of financial cost of multimedia technology, and obtaining a sufficient knowledge base.

3.6 Summary: Characteristics of Adaptive E-learning Systems

The following features have been identified in the adaptive e-learning systems detailed above.

- **Modelling the user** – all of the systems studied build a model of the student in order to provide the best learning experience possible. The ITLS builds a model of the user based on their performance in the tests provided. The NetCoach system builds a user model based on the users selections, and behaviour when using the system. The MANIC system builds its model from the users’ “pretest”, and the information that the user chooses to view. Virvou & Moundridou (2000) base the student model on previous interactions and the overall perceived intelligence and ability. InterBook records any data that it believes would aid learning – including the time taken to read a page, the route taken through the system, and the performance in multiple choice exercises. PAT OnLine uses the student’s performance in problem solving, and InterBook and PAT OnLine cooperate with each other by sharing the information that they have gained on a particular user. ELM-ART II uses cognitive theory to analyse programming code answers to ascertain learner characteristics. The AVANTI system builds its model by identifying user characteristics from the interaction that takes place – this includes identifying any disabilities that the user may have, as well as level of expertise and interests. NASAs CLIPS system builds a user profile from the student’s performance in tests.

- **Adapting the courseware** – all of the systems adapt the content that they provide for the user in accordance to what the system believes to be the most appropriate form and level of difficulty. The ITLS adapts the content provided and NetCoach employed “curriculum sequencing” and
"adaptive annotation of links" according to the user profile. The MANIC system’s content is adapted based on the student model, and selections made by the student themselves. PAT OnLine adapts the level of the information presented in accordance to the user model. The AVANTI system adapts the "hypermedia documents" according to the user model – this includes bookmarks, text completion facilities and aid with task completion, as well as personalised content and navigation. NASA’s CLIPS adapts the training information to accommodate for the different levels of user, and different features such as nationality.

- Providing adaptive feedback – some of the systems studied provide adapted feedback to the learner. This is an integral part of the ILTS system, as the feedback to the user is the main adaptive feature, and is based on what the student misunderstood when completing exercises. Virvou & Moundridou (2000)’s system adapts the feedback to the user according to the “pre-test” that is taken, and performance in further tests. PAT OnLine provides exercises for the learner to complete, and feedback on those exercises according to the learner’s performance. ELM -ART II adapts the messages provided for the user, advising whether a page should be visited or not, as well as provide personalised examples, feedback and help messages, to aid learning. The feedback provided by the CLIPS system concerns whether the system sees the user as a novice or an expert.

- Adapting the presentation of the information – all of the systems adapt the way that the information is presented to the user, in accordance to the user model. The NetCoach employs “curriculum sequencing”, which orders the pages in the most appropriate way to maximise learning. Virvou & Moundridou (2000) incorporated a facility to personalise the navigation through the material, as did Brusilovsky (1997) by adapting the annotation of links, help facilities and navigation. The ELM-ART II system uses a colour-coding method to advise the user on how to navigate their way through the system – it tells them whether they have already viewed a page or whether are advised to view it. The AVANTI system adapts the presentation to what is easiest for the user to understand, e.g. by choosing between text and graphics to convey information.

- Users actively contribute to the user model – this is as opposed to the model being solely based on inferences about how long the user views a page etc. In the ILTS system, the MANIC system, the “Web –based authoring tool for algebra-related ITS”, and PAT OnLine provide the user with tests and examples to complete. The “Web –based authoring tool for algebra-related ITS” system also accepts input from the student’s supervisor, to build the student model.

3.7 Conclusion

This chapter has outlined the advantages that implementing adaptivity can bring to an e-learning system and thus act as an aid to learning. Examples have been provided illustrating its effectiveness particularly with student performance, with the use of different mechanisms to change the content and presentation, as well as provide feedback to the user.
Chapter 4 – How can the adaptivity of an e-learning system be addressed via UCD?

4.1 Introduction
The previous chapters have outlined the features of User Centred Design and adaptive e-learning as separate entities and the aim of this chapter is to combine the two theories, resulting in an explanation of the benefits of employing UCD in the design and testing of adaptive e-learning systems.

4.2 UCD & adaptive e-learning combined
The motivation behind implementing a web based e-learning tool is to enable the learner to gain the knowledge that they require, in the easiest and most appropriate way, and to generally enhance the learning experience. The use of UCD in this application could increase the likelihood of the realisation of this aim. Applying UCD to adaptive e-learning can enhance the site, and therefore the learning experience, by gaining information about the users of the site during the design and testing processes, and this information can be used when designing and implementing the adaptive features.

In an adaptive e-learning system, the system adapts the content, layout and presentation to each individual user (see section 3.5), and by involving both sets of users in the design and testing of the system, these three features can be improved.

Adaptive content can be designed in accordance to the information provided by both sets of users (i.e. teachers and learners). The learners would be involved, so that the different levels of content that were required could be determined. This can be done by finding out exactly who the learners are, as this will illustrate the levels at which the information is required to be. For example, if the set of users is comprised of learners on a specific university undergraduate course, the adaptivity could be based on this, and the information would not need to be in an organisational context, or to a PhD standard.

The teachers can be involved in this aspect because they define the content that is put into the site. They can also test the adaptive features to ensure that the level of content is appropriate for the kind of user involved – this could be done with the use of scenarios. Learners would be more useful in testing the prototype as they could see if the level of content was useful to them, based on their abilities. This is likely to be more successful, than if the learners were asked to provide their requirements for the content; because the aim of such a site is for the learners to learn. Therefore
they would not know anything about the subject matter when the site is at the requirements gathering stage.

The design of the adaptive layout of the site (or “curriculum sequencing”, Weber et al 2001) can be influenced by the input of the users. It is possible that the learners could provide information concerning their preferable learning patterns and techniques (for example approaching a section little by little or with an overview of the whole subject). However this is unlikely to prove useful, as it is very difficult for people to define such a process. The teachers could use their teaching experience to suggest an order for the material (for example, the order that has been preferable when teaching in the classroom).

However, the layout of the material is more likely to be improved, and affected by the involvement of the users, in the testing phase. It is at this point that learners could experiment with different ordering of material, and demonstrate their preferences. This could be compared to a prototype user model and thus the designers would obtain further in formation concerning the accuracy of a user model and how this can be represented by the layout of the information. In such systems as ELM -ART II, learners could state if they agree with the advice concerning whether a page should be viewed at the time that the system recommends. Both learners and teachers could also provide suggestions on alternative ways of ordering the material and this may be more successful, as their thoughts would be triggered by a prototype, as opposed to attempting to suggest ideas “from scratch” in the requirements gathering stage. Alternatively, two students with similar levels of ability could be presented with the material in different sequences, and their performances compared. This process would not only attempt to verify the “curriculum sequencing” mechanism but the student model as well.

The way that the information is presented can also be altered, according to information provided by the user. Learners may express a preference for pictures wherever possible, as opposed to text, as large volumes of text can be difficult to read and digest, especially when on a computer screen. This preference may be limited to users with little computer experience or knowledge of the subject of the site, but this also cannot be guaranteed. When specifying the content of the site, teachers can employ different methods of expressing the same concept, in order to make learning as easy as possible.

The format of the feedback can also be planned according to user input. When designing such feedback it would be useful to know if learners would be prepared to complete online tests if they were not compulsory. The format of such tests could also be decided based on the results of such user surveys – for example whether to use multiple choice questions and whether the users would prefer a grade or further assistance such as more reading based on their shortcomings in the tests.
Designers would also like to know if learners would be likely to follow any recommended links to provide additional knowledge, as they would provide such links if deemed necessary.

The aim in implementing UCD in the design of adaptive e-learning systems is to make the site as effective as possible as a medium for learning. It should form a basis for the kind of information that should be provided in the student model and how the learner would like the student model to be used. Finding out more about the users should make the adaptivity of the site more effective. Obviously this process will not produce the perfect system with a totally accurate user model; however, the information provided in a user survey should assist the design of the system. The input of the learners will be more valuable in the testing phase, as they will be able to comment on material presented before them, as opposed to attempting to think about such things as learning patterns and preferences with little stimulus. The teachers could test the system to verify its educational capabilities, including the accuracy of the student model (as a representation of a certain kind of student), and the decisions made about a learner based on this (i.e. if they are the right decisions for that kind of student). The effectiveness of the site as an educational tool could be assessed, by comparing student performance between a group of students with similar capabilities – one of whom could have no interaction with the system, and others could use different versions of the system. This would assess the accuracy of the student model; the effectiveness of the decisions made by the system based on this model, and the overall benefits that the system offers.

4.3 Guidelines for producing an adaptive e-learning web site by applying UCD.

The following guidelines have been produced to advise developers of adaptive e-learning web sites, in order to help them take advantage of the benefits that User Centred Design can offer. The steps are in accordance with a basic systems lifecycle (see appendix C), and are based on the findings of section 2.7 of this report.

1. **System definition**

The context and the reasons for the development of the system must be clearly understood, in order to be in a position to produce a requirements specification.

The first step is to identify the users of the proposed system – i.e. the learners and the teachers. The teachers may be those who instigate the development of the system, and provide the content. The learners will be more difficult to identify – if the system is used in conjunction with a course, then those taking that course will be identified as learners, however, unless the site is part of an intranet, there will also be additional users who encounter the site independent this course, who must also be identified wherever possible.
It must also be made clear, what the system will actually do. At this point, all features of the prospective system must be clearly identified. This includes whether the site would just provide information, or whether it would provide links to areas within the site, or outside of the site. The designers must also know the answers to a number of questions, including:

- **Why** is the system being developed? What are the overall objectives? How will the system be judged as a success? What are the constraints?
- What are the usability requirements of the system?
- Would the site be used in conjunction with a course from an educational establishment, or by learners who are self-taught, and encounter this site through a search engine?
- Would the site employ a form of online assessment – if so what form would this take?
- The details of the adaptivity would need to be established – what would be adapted and how? Would the content, navigation, display, feedback all be personalised, or only a combination of these four?
- What tasks would the teachers perform – if any? Would they edit the content of the page? Would they employ a message board within the site? Would they have input into the marking of the assessment, or would the computer complete this task automatically? How much control would the teachers have over the adaptivity of the system? Would they be able to override the decision-making mechanisms, such as the student model, and if so – how?
- How will the users obtain assistance?

This is known as the requirements gathering stage, and the users should be involved in it. The teachers can specify the answers to the above questions – the system is being designed for their use, they can state exactly what they want from it. The learners would be able to provide information of what they want from the system, but extracting this information from learners that cannot be identified or contacted, means that this information may not be gained as yet. The designers can commence this process by interviewing the teachers, and providing questionnaires for the teachers to complete. When the results are analysed, the teachers can then be involved in focus groups involving brainstorming, to ascertain the details of the system. The designers can use the information that was gained from the interviews and questionnaires to establish the finer details of the user requirements, and the teachers can use each other’s ideas to stimulate their thoughts concerning the site. These sessions will become more structured as time progresses – the ideas will become less raw and more concrete as more thought is put into them.

The learners can also be involved in a similar way, however, the learners may be difficult to identify and even if they can be contacted, may be apprehensive to devote much time to this stage, as there may be little perceived benefit to them. Methods could be employed to encourage the learners to
become involved, including monetary incentives, or the prospect of winning some form of prize. However, the learners may provide little information that is of use to the designers, at this stage.

2. Technical requirements
Once the features that are required of the system have been identified, they must be translated into the technical requirements for the system. This phase may require little involvement on the part of the users, as they would probably not possess the technical expertise required, but this may not be the case. The results from this phase would be a set of prototypes for the users to study, and the users may need to be consulted on any additional matters that would arise from this phase.

3. Evaluation of prototypes
The teachers must be involved in the evaluation of the prototypes, as the developers can carry out the technical specification, but the transition from user requirements to the eventual system may produce some inconsistencies. Instead of these errors being discovered after the implementation of the entire system, the production of prototypes will be a cheaper and easier way to evaluate the proposed system. When a version of the system has been verified by the teachers, the developers can increase the sophistication of the prototypes, until a fully working site is achieved.

At this stage, the involvement that the teachers and the learners will be available and prepared to engage in, will be dependent on the circumstances of the project. If the teachers are available, they can evaluate the prototypes produced for their aspect of the system and suggest modifications. If there were a number of teachers available, this could be carried out in focus groups, where the teachers convene and discuss the prototypes provided by the developers. Questionnaires and interviews could also be used, in order to gain the maximum information possible. If only one teacher was available or involved in the project, they would need to complete questionnaires and participate in interviews. The teachers would also have to assess the adaptivity of the learners’ system, specifically, they would attempt to ensure that the student model is accurately represented by the adaptive features – for example, if a student model was created which represented a certain kind of student, the teacher may be able to judge if the changes in the site would be beneficial to that kind of student’s learning. The teachers could also assess the learners’ aspects of the system, to ensure that the content is correct, and the usability is sound. If possible, a representative group of teachers should be involved, however this could be difficult if the number of teachers that the site was being created for was small, and is dependent on the time that the teachers have available.

The learners may be available to test the prototypes, and if so, the format could follow that of the teachers’ assessment. If there were a number of learners available, they could participate in focus groups, which involve a discussion of the prototypes and their effectiveness as a learning tool (i.e. whether the learners felt they learned from using the site). When the prototypes become more
sophisticated and move away from being paper based, and onto the computer screen, the learners could be observed interacting with the system. They would be encouraged to think aloud as they are using the system, so that an insight into their cognitive patterns could be gained. If possible, this group should also be a representative sample, including learners with different levels of ability in the subject matter, and different levels of experience with computers. If the learners were unavailable to test the prototypes in person, they could be examined remotely. Again, incentives may have to be provided to encourage learner participation.

Both the learners and the teachers should be questioned before and after their testing of the prototypes, to compare the effect of their use.

4. Implementation and launch of the web site
The users may also have little input into the implementation of the system, as the knowledge required for this phase probably rests more with the developers.

This is the final phase of the project, but at the same time is ongoing, and requires the iteration of previous phases when revision of the site is required. In this phase, the teachers can monitor the success of the web site - what was believed to be an effective tool or feature in the design phases, may not prove to have been a correct decision in practice. The teachers will also be required to suggest any alterations to the site, if necessary. This may be in accordance to changes in syllabus, new research or the development of a new technology or simply a change in the opinion of the teacher, about what should be taught by the web site.

It is at this point that the learners will have the opportunity to provide more information concerning the use of the site. The learners must be given the opportunity to comment on the site – this is crucial in the early months of the use of the site, as there will still be features that are not as good as they would be if the learners could comment. Although this means that the learners will essentially testing the site and acting as “guinea-pigs”, which is fairly unsatisfactory, this is the most feasible form of involvement that the users will experience.

It is therefore important to stress the iterative nature of the design process – if the learners and teachers have sufficient mechanisms to be involved in the design of the site, it will always be necessary to redefine user needs and technical requirements, and re-implement features.
4.4 How can users be involved in the design of an adaptive e-learning system - an empirical study

4.4.1 Objectives
In order to evaluate the guidelines above, a set of questionnaires has been released. The questionnaires have been used in conjunction with the online tutorial “User Centred Web Design” at http://www.dcs.napier.ac.uk/~mm/im/tutorial/userwebdesign.html. This tutorial has been selected according to the following criteria:

- Its subject matter is User Centred Web Design – this area is consistent with the material researched in this project, which will aid the improvements made to the site, in terms of content.
- It is not adaptive to the user – this will aid in the illustration of the need and potential benefits of adaptivity when the learners’ interaction is studied.
- The content is aimed at the appropriate level for the students questioned as it has been produced by a university (NAPIER), so would be of a degree standard – not intended for professional use.
- It would be easily accessible to all of the participants of the investigation.

Two sets of questionnaires have been issued, one to the potential teachers of an e-learning web site and, one to a group of students who would learn from such a site. Both versions can be found in appendix C.

The above site was not included in the version of the questionnaires submitted to the teacher element, because sufficient teachers of the subject of user centred design could not be found, only teachers who were experienced in the development of e-learning (both adaptive and non-adaptive).

The objectives in issuing the questionnaires to teachers are as follows:

1. To discover the experience of teachers in the design and implementation of adaptive e-learning sites.
2. If teachers have been involved in such sites, it is aimed to gain the details of such involvement. I hope to find out the teachers opinions on the level of involvement that they experienced, and their opinions on the kind of involvement that they would like and that they would think possible and realistic.
3. If teachers have never been involved in the development of such a system, I hope to discover if they would consider the implementation such systems, and the level of involvement that they would like to have in its design.
4. To verify any assumptions made about the teaching process – especially concerning motivations to create adaptive e-learning systems, and teaching in general. It is also hoped to understand any reasons for the avoidance of using such systems if this is the case.
It is appreciated that if a teacher has never been involved in the development of an adaptive web-based e-learning system; their comments on degree of involvement will be fairly hypothetical. This will be taken into account with the analysis of results.

The issue of the questionnaires to the learners fulfils the following objectives:

1. The questionnaire ascertains the learner’s impression of the site as a non-adaptive e-learning site. The questions are hoped to extract the learner’s perspective on using an online learning system and whether it is preferable to the traditional method of learning.

2. As this site is non-adaptive, it is hoped that the learners provide details concerning whether they believe that the learning experience would have been improved by adaptability. Any problems were experienced in the use of the site will be established, and whether such problems could be addressed by the use of adaptability.

3. The questionnaire also ascertains the learners’ opinions on user centred design, and how far they (as users) would have liked to have been involved in the development of the site, if given the opportunity according to the application of UCD. This section will hopefully examine the feasibility of involving the learners in the design and implementation of a web based adaptive e-learning site.

The overall objective of this questionnaire is to verify the guidelines produced in the previous section.

4.4.2 Participants
The set of participants is comprised of two groups of users – possible teachers and people who have experience in the implementation of adaptive and/or e-learning systems, and potential learners of User-Centred Design.

4.4.2.1 Teachers
The teachers involved have been selected with the help of my project supervisor.
Six teachers, two flexible learning officers and two PhD students have been approached in this study – all of whom possess extensive experience in the study or practice of teaching, and some with adaptive systems. A short meeting was held with one teacher of User-Centred Design, which involved their completion of a questionnaire, in order to gain a perspective on the teaching of this subject.

4.4.2.2. Learners
I issued the learner version of my questionnaire to a number of students in the School of Computing. These learners were divided into two sub-categories: those who were familiar with UCD (through studying the module IN33) and those who were not. Therefore five third year Information Systems
students and twenty Computer Scientists (who had no knowledge of UCD) were contacted. A higher volume of Computer Scientists were contacted due to an expected low rate of reply.

4.4.3 Materials and procedure

4.4.3.1 Introduction

The questionnaires released (to the learners in particular) are a form of usability testing, and their content has been based on research on usability testing and questionnaire formulation. Despite the problems associated with surveying the users (the learners in particular) identified above, usability testing is still an important part of assessing a system. Nielsen (1996) states that the users must be surveyed, especially when investigating “subjective satisfaction and possible anxieties, which are hard to measure objectively”, and that user preferences and motivations can be discovered. He recommends building a prototype, in order to stimulate the user’s thoughts, and the use of the Napier site performs such a role, by acting as a stimulus for the learners. He concedes that this method of data collection is indirect, in that it only provides the user’s opinion of the site and does not relate to the user interface itself, and he also acknowledges the likelihood of a low response rate to a survey. However, its advantages outweigh the shortcomings. The problems in analysing open questions individually have been reduced by keeping the number of questionnaires released to a relatively low number. This is in accordance with Nielsen’s empirical research, which states that “you only need to test with five users” (2000). The volume of additional information gained from a high number of users is not in proportion with the volume of effort and resources required to test a large number of users, and more users tend to state the same as previous users, i.e., “as you add more and more users, you learn less and less because you will keep seeing the same things again and again”.

4.4.3.2 The questionnaires

The questions in the teachers’ version of the questionnaire aimed to address the experiences that the participants had in teaching, e-learning and User Centred Design. The learners’ version aimed to examine the user’s interaction with the e-learning site, and their opinions of possible involvement in its design.

The questionnaires were formulated based on the objectives identified in section 4.4.1, and can be found in appendix D.

In spite of the recommendations by Nielsen (1999) and Robson (1993), it was decided to be appropriate for this situation, that a combination of open and closed questions be used. Closed questions have been used, due to the advantages that their answering presents (i.e., forcing the recipient to form an opinion and only requiring the statement of a simple fact) and the ease of analysis. However, a number of open questions have been used, because the recipients have their
own individual experiences of each aspect being analysed, and so closed questions would not reveal each individual’s opinions of the subjects in question.

4.4.4 Results

4.4.4.1 Teachers

Nine completed questionnaires were received from the “teacher” element of the study, from eight recipients. One teacher completed two questionnaires concerning different projects, with different levels of involvement and so they are treated as separate. However, for the first question, the two questionnaires are to be treated as one, due to the fact that it is a question concerning the participant’s opinion, and using the answer twice would be misrepresentative of the sample.

The first question in the teacher questionnaire (appendix D) concerns a teacher’s motivations to teach, and six out of eight teachers confirmed that they do what they do because they want to make their knowledge available to as many as possible. Of the participants who did not confirm this, one did not provide an explanation. The other identified that the nature of their work is not to provide knowledge, but to provide a platform to facilitate improved teaching (i.e. when someone else is actually performing the act of teaching), and so focuses their work on understanding the learning process.

Of the nine participants, six had implemented e-learning systems, and of those systems described, three were adaptive. Therefore the teachers have been divided into two sub-categories, those who possess experience in e-learning and those who do not. Of the six who implemented e-learning material, four found it had enhanced student performance, and two did not have access to the student performance evaluations.

The kind of involvement that the teachers who had implemented e-learning material, had in the system varies between each participant and is shown in the table below – each participant is numbered 1-6.

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<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge provided for material</td>
<td></td>
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<tr>
<td>Teacher requirements provided</td>
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<tr>
<td>Learner requirements provided</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Design of teacher interface</td>
<td></td>
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<td></td>
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<tr>
<td>Design of learner interface</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Testing teachers prototypes</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Testing learner prototypes</td>
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</table>

Table 1 – The Participation Experienced by Teachers (numbered 1-6).
The results in table 1 do not have any particular correlation that would represent a pattern in user involvement. However, the characteristics of each instance can be drawn from the table. For example, participant 2 was **only concerned with the design and testing of the interface**, participant 3 was involved in **every phase** of the development, but participant 4 **only provided the knowledge** required. Participants 5 and 6 can be compared, as participant 5 was **concerned with the teachers’ element**, whereas participant 6 was only concerned with the **learners’ aspect**. Overall, this illustrates that user participation comes in **different forms in each instance**, according to **necessity**, and the most appropriate **utilisation of skills**. The level of involvement is therefore **not exclusive to each individual**, because participants 3 and 4 are the same person, but involve very different levels of participation.

A crucial factor that is determined by this questionnaire is whether the participants were **satisfied with the level of involvement** that they experienced. Having experienced the development of the respective systems “first hand”, four out of the six were happy with the level of involvement that they had – they did not find it too much, nor do they believe further involvement would have benefited the system. Two would have **preferred increased involvement**, and it is interesting to note that **one of those two was participant 3**. Therefore **all six participants** (as users) were **not opposed to being involved in the system development**.

Three of the teachers surveyed have no experience in developing e-learning systems – all three have **considered** their use, but have been prevented from doing so, due to **resource constraints** and **lack of support** from superiors. None had considered employing any form of **online assessment**. Table 2 shows the kind of involvement that this group of three teachers would be prepared to engage in, if such an opportunity was to arise.

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<th></th>
<th>1</th>
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</thead>
<tbody>
<tr>
<td>Not at all</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide material for site</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Provide input into design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involvement in requirements gathering</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Testing of prototypes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Every decision made by designers</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 2 – The kind of participation that teachers without experience in e-learning (numbered 1-3) may be prepared to take part in.
Table 2 shows a reluctance for the participants to become involved in the development of a system when they have no experience of e-learning. Participant 1 would only be prepared to be involved in prototype testing, and participant 2 would only be involved in the design. Only participant 3 was prepared to be involved to a greater extent. All participants identified that the extent of their involvement would be dependent on the size of the project (and so how much work was expected of them), and time and other constraints. It should be noted that the results of this section are hypothetical, as they are not based on the participants actual experiences, but rather on what they think that they would want to do in a given situation.

Out of all nine participants, the level of UCD experience held by them is shown below. Graph 1- The levels of UCD knowledge possessed by the teachers

4.4.4.2 Learners

In total, eleven questionnaires were returned by the learners – six by the Computer Scientists, and five by the Information System students. Their opinions regarding their level of experience with computers and the Internet are shown in the graph below:
The confidence reflected in the results in graph 2 can probably be expected from a group of computing students.

In this questionnaire, two questions have involved the recipient stating how far they agree or disagree with a statement. In order to find the average opinion, a scoring system has been employed, where a higher number indicates greater agreement.

The scores were calculated by multiplying the score that has been awarded by each participant, by the number of participants that gave the statement that score. Therefore, if all eleven learners strongly disagreed with a statement, that statement would be given a score of 11 (11 learners multiplied by the grade they all gave it – 1). Alternatively, if 4 students strongly disagreed, but 7 students strongly agreed, the statement would be given a score of 39 (4+35). If such an extreme example should arise, further documentation would also be provided. The lowest score that a statement could receive is 11 (if every recipient stated “strongly disagree”) and the highest would be 55 (all 11 recipients, multiplied by awarding a score of 5).

The first of these two questions provided the following data:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Score</th>
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<tbody>
<tr>
<td>a “I find it difficult to familiarise myself with an interface”</td>
<td>27</td>
</tr>
<tr>
<td>b “I prefer to browse a system myself, rather than be guided”</td>
<td>42</td>
</tr>
<tr>
<td>c “I never use help sections”</td>
<td>30</td>
</tr>
<tr>
<td>d “I often have trouble using a system, because it uses too many technical terms”</td>
<td>25</td>
</tr>
<tr>
<td>e “I grow impatient when a system treats me as if I am stupid”</td>
<td>41</td>
</tr>
</tbody>
</table>
Six out of the eleven had used an online tutoring tool before, and nine believed that their completion of an online test would improve their learning. However, when this question was translated into practice (i.e. “would you complete such tests in your university modules?”), only four learners stated that they would, most citing a lack of time, and a dislike for reading from a screen. Four out of the eleven participants said that they would not like a system to be adaptive – all of whom were computer scientists, and stated that they do not have the confidence that the computers would make the correct decisions (“they never get it right”), and one participant believes that they are “in a better position to decide what I want to learn – I do not like the idea of a computer being in control of the learning process”.

The learner who had a thorough knowledge of UCD and the learners who are “familiar with the concepts” comprise the Information Systems students, and so all of the Computer Scientists in the sample either only know the basic concepts, or have never encountered it.

Nine out of the eleven stated that the use of the “User Centred Web Design” website provided enhanced their learning experience. The second of the “statement agreement” questions used the same scoring system as above. The question was specifically based on this site, and provided the following data:

<table>
<thead>
<tr>
<th>Statement</th>
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<tr>
<td>“I got bored when reading the material”</td>
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Table 4 – Learners opinions on the web-site examined

<p>| | | |</p>
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<tbody>
<tr>
<td>b</td>
<td>“I did not understand the material”</td>
<td>19</td>
</tr>
<tr>
<td>c</td>
<td>“I possessed enough skill to navigate the tutorial successfully”</td>
<td>51</td>
</tr>
<tr>
<td>d</td>
<td>“I didn’t mind having to scroll through the whole material to find a topic that I was interested in”</td>
<td>24</td>
</tr>
<tr>
<td>e</td>
<td>“I found the display made it difficult to read the information”</td>
<td>37</td>
</tr>
<tr>
<td>f</td>
<td>“I found aspects of the display annoying”</td>
<td>34</td>
</tr>
<tr>
<td>g</td>
<td>“I found a lot of the information provided to be irrelevant”</td>
<td>34</td>
</tr>
<tr>
<td>h</td>
<td>“I felt that I learnt a lot from reading this material”</td>
<td>24</td>
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</table>

Nine out of the eleven surveyed would have been **happy to provide information** about themselves – most were aware that this information would be used to result in an **improved interaction** with the site, although many were, at the same time, sceptical about their information being used inappropriately, e.g. for junk mail. Seven believed that their learning would have been **improved by the completion of a test** at the end. Only three would change their opinion of the above if they knew that the information provided by these two means would be used to **adapt** the site to their needs (five stated that they would not change their opinion had already stated that they would be happy to provide information and complete online tests). Seven learners believed that the UCD site would have been **improved with their input** (in both content and design).

The following data was obtained, when asking the learners how far they would be prepared to be involved in the design of this (or a similar) e-learning site.

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<th>10</th>
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<tbody>
<tr>
<td>Completing a questionnaire</td>
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<tr>
<td>Participating in focus groups</td>
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<td></td>
<td></td>
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<tr>
<td>Evaluating prototypes remotely</td>
<td></td>
<td></td>
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<tr>
<td>Testing prototypes in person</td>
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Table 5 – Learners feelings on participating in the development of an e-learning site (learners are numbered 1-10)

The eleventh participant was omitted from table 5, as he stated that he “possibly” may take part in each part of the design and implementation process, except for the participation in focus groups, due to the fact that “it doesn’t work to ask people what they want – they don’t know!” . Participants 1-5 (and 11) formed the Computer Science contingent, and there is a slight trend of an **increased willingness to participate, by the Information Systems participants**: each I.S. student was willing
to provide some form of input, and participants 7 and 8 (one of whom possessed a thorough knowledge of UCD, and the other was familiar with it) were willing to become involved to a great extent. Three (“possibly” four) out of the six Computer Scientists displayed an unwillingness to provide any involvement.

4.4.5 Discussion

4.4.5.1 Teachers

All of the teachers who employed e-learning stated that this enhanced the performance of their students and all believed that this was due to the fact that the students became more motivated. One participant believes that this is due to the fact that learners respond to this “networked learning environment” and so become more motivated and better equipped to learn more. Another participant attributed the increased student performance to the facilitation of “varied and rich human interaction producing discussions of a very high quality” between “peers and experts…..enriching their learning at whatever time of day and night they chose…extending the range and depth of the course”.

Of the teachers who had participated in the development of an e-learning system, all were satisfied with the idea of being involved in the development – two wished to be involved more, and this illustrates the validity of involving this section of users in development. This also shows that the degree of involvement experienced is a representation of the teachers’ opinions regarding participation, or that they are of the opinion that the more involvement the better. The different forms that each involvement took can be explained by the nature of each project. One participant commented that “anything involving real people [requires] a lot of variables to be considered…..what you want to have is a multi-disciplinary team”, and so the lack of involvement of a participant in a certain area does not necessarily reflect a flaw in the theory of UCD. Another commented on the fact that, in an ideal world, “the involvement of users in the design process is an admirable aim…[and]…..circumstances sometimes conspire to dilute or confound our best efforts”.

He goes on to detail the example of communication problems in his project, as many of the users spoke different languages, and so the employment of a translator meant no direct communication between the designers and the users, and so “the design process may be distorted”.

Overall, all teachers who had employed e-learning tools found the experience of being involved in the design process to be successful. Of the three who employed adaptive tools, all found that this feature further enhanced the learning process, due to the nature of adaptivity (a more tailored interaction etc). Of the three teachers who had not implemented any e-learning tools, all cited situational obstacles, rather than a lack of confidence in the concept.
4.4.5.2 Learners

As expected – a high level of confidence in the participants ability with computers and the Internet was displayed. Three participants (all of whom studied Information Systems) stated a higher level of confidence in their abilities with the Internet, rather than computers in general, and all others stated their abilities in each area to be equal.

The following “statement agreement” questions were aimed to provide information on the users opinions of webpage interaction, and showed the following information:

a) The learners do not find it difficult to familiarise themselves with a new interface.

b) The learners prefer to browse a system themselves, rather than be guided. Comments made later in the questionnaire by some, suggest that this is due to the fact that the learners want to view all of the information available to them, and select the information that they deem necessary to view.

c) There was a fairly even spread of results concerning the use of help sections – i.e. some do use them and some do not. When compared to part a) of this question, this shows that some users use the help sections because they believe that they will provide help, while others feel that help sections will be of no use to them; this is rather than the fact that the learners in question need to use the help sections because they cannot use the interface effectively.

d) The learners do not often find that they cannot use a system, because it employs too many technical terms. This can also be expected of the learners as they are at a fairly high level of computer literacy.

e) Most learners also agreed that they do grow impatient if a system asks them irrelevant questions, or provides them with useless sources. This is probably also due to the fact that the learners questioned possess enough experience with computers to make correct decisions and so they find it unnecessary to be asked if they are “sure they want to do that” etc.

f) The learners also expressed a preference for a system to be personalised by them, and this is probably again due to the confidence that this set of learners have in their ability to use a system – less confident users may fear making a irreversible mistake when changing their preferences.

These results verify that the results provided are accurate, in that problems with interaction, understanding and willingness to be involved in systems development etc. are not due to the lack of experience that the participants had with computers and the internet, but with shortcomings with the system in question.

Nine learners believed that, in theory the use of online tests would improve their learning, however only four of those learners stated that they would complete such tests in their university modules (if non-compulsory). It is interesting to note the scepticism of the Computer Scientists with respect to adaptivity – four out of the six surveyed stated that they do not believe such a system would be effective, whereas all of the Information Systems students (and two Computer Scientists) would prefer an adaptive system. This maybe due to the fact that the Computer Scientists have more
experience with programming, and so believed that “it would not work”, whereas I.S. students are more familiar with the human side of computers – therefore they could see the benefits of an adaptive system, in terms of interaction and user-friendliness.

All of the students who declared themselves “familiar with the concepts of UCD” were I.S. students, and, accordingly, they all showed a willingness to be involved with the stages of designing a web-based e-learning tool (see graph 3 and table 5). Two of the five were prepared to be involved at every stage, and the remaining three stated such reasons as a lack of time, and that they would not be qualified to make such a decision until they knew how important such a system would be to their learning. The three C.S. students who had never come across UCD were the same students that were unwilling to be involved in any stages of the development. This clearly illustrates that if the users are aware of UCD theory and the benefits that UCD brings; they will be more willing to be involved in the design and implementation of the system.

When questioned about their interaction with the User Centred Web Design web site, the following was found:

a) A slight tendency was shown that the learners found the material boring, which was displayed more by the Computer Scientists, to whom the material was unfamiliar. It is likely that this was due to whether the material was interesting to the student, and could have been affected by the layout of the page.

b) Strong evidence was provided to illustrate that the participants understood the material in the tutorial - this shows that it was pitched at the right level. This is due to the fact that the web site was written by a university, for degree level students.

c) There was also strong agreement that the students possessed enough skill to navigate the tutorial successfully, which was also due to the level of experience and confidence that the students possess.

d) Strong evidence was provided that the students did not appreciate having to scroll through all of the material, and several identified the lack of some form of index as a problem with the site.

e) The learners showed indifference with regard to whether the display made it difficult to read the information.

f) The learners were also indifferent concerning the level of annoyance of the display.

g) The users also did not show a strong opinion on whether any of the information in the tutorial seemed irrelevant – the Computer Scientists citing that their lack of knowledge in the area prevented them from commenting.

h) The learners concluded that they had not especially learned a great deal from this tutorial. This could be explained that the subject matter of the tutorial was of little interest to the participants –
if it was, they may have paid more attention to what it was trying to teach them. If they were interested in the subject, they would have visited the site to learn about User Centred Web Design, as opposed to visiting it for the purposes of this questionnaire.

Again, a correlation was shown by the users who would be prepared to provide information to construct a user model, and those who were familiar with User Centred Design. Seven learners stated that the site would have been improved with their input (thus advocating UCD), and the remaining four believed that the site was adequate and no more improvements could be made, as far as they could tell.

4.4.5.3 Conclusion

Of all of the teachers who possessed practical experience in implementing systems, none could provide any reasons for the avoidance of UCD, and of both sets of teachers, no negative features of this discipline were identified. Every teacher who had implemented e-learning systems (who had access to student performance results) stated that the use of e-learning and online testing mechanisms had enhanced student performance. All of the teachers who were studied also stated that the use of adaptivity in e-learning systems further enhanced the quality of the systems and therefore the learning.

Most of the learners surveyed stated that they could see the benefits of completing online tests on material covered in a web-based tutorial, such as the one examined, however many identified a lack of available time and motivation to do so. The learners who were familiar with the concepts of UCD were willing to be involved in the design process, as opposed to those who were unfamiliar with the benefits. Some learners are happy to provide information for, and employ the use of, an adaptive system, but some are also sceptical of the extent to which such a system would be effective.

4.5 Conclusion - Verification of the guidelines

The success of involving the users in the development of an adaptive e-learning system has been verified in the discussion of the results of the questionnaires – section 4.4.5.

One of the main functions of the questionnaires was to confirm or dispute the guidelines produced in section 4.3 of this chapter (the other function being to use the information gained from the learners for the alteration of the web site).

1. System definition

The questionnaire showed that most of the users in this sample would be prepared to be involved in the requirements gathering activities of a project involving adaptive e-learning. The questionnaires
illustrated a strong pattern linking a previous knowledge of UCD to a willingness to participate. A solution to the problem of an unwillingness to be involved could be that when attempting to recruit users, it may be advisable to provide them with information about the theory behind User Centred Design, and why it is so effective. This may help them to understand that their involvement may make a direct contribution to the production of an effective learning tool. Another solution could be to limit the involvement of the learners to those who are already familiar with the benefits of UCD. This may be possible for the production of an adaptive e-learning site within a computing department of a university (for example by approaching students who had passed a module such as IN33), however if the content of the site was unrelated to the area of computing, this could be more difficult to achieve.

2. Technical requirements
The questionnaires confirmed that many teachers and most of the learners would not have the will or indeed the capabilities to be involved in the development of the technical requirements of such a project. However a minority stated that they would, which illustrates that the exclusion of users from this phase is not a given rule. The circumstances of individual projects, and the abilities of the people involved will dictate the level of involvement in this phase.

3. Evaluation of prototypes
The teachers’ opinions concerning the testing of prototypes were divided – this shows that this may not be the area that the teachers would be willing to participate in, or they may have simply not had the time. Some were prepared to be involved in the testing, which also shows that this is dependent on the circumstances of the project. A small proportion of the learners were prepared to be involved in this area, however this could be improved if incentives were offered to them. The learners could not provide a conclusive opinion as to whether they found any of the information irrelevant, this may not be the case if the learners were viewing the site to learn, and not for the purposes of a questionnaire, therefore caution must be exercised when employing learners to assess the applicability of the content.

4. Implementation and launch of the web-site
Again, most users (both learners and teachers) did not express a willingness to be involved in the actual implementation of the system, but as some did express a wish to be involved as far as possible in every stage of development, the possibility of user participation in implementation cannot be discounted. This also depends on the level of skill possessed by the users from both groups – for example they may be skilled programmers.

When the web-site is launched the developmental process is not complete as the quality of the site will be heavily reliant on feedback from the learners. Due to the fact that there was no feedback capability on the web site that the questionnaires were based on, the likelihood that the users would provide feedback could not be ascertained. In hindsight, the learners’ general opinions on providing feedback to inadequate web sites could have been investigated.
Chapter 5 – The re-design of the Napier “User Centred Web Design” web site

5.1 Introduction

The aim of this chapter is to produce a prototype of an adaptive e-learning system, based on the site studied by the learners when completing the questionnaires (see section 4.4). Two versions of the site have been constructed – one aimed at a beginner’s level, and one at an advanced level. The interface issues raised by the results of the questionnaires will also be dealt with in the two new sites, and research concerning e-learning design will also be incorporated.

The original site can be viewed at: http://www.dcs.napier.ac.uk/~mm/im/tutorial/userwebdesign.html Screenshot 1 in appendix E illustrates the beginning of the page. The version of the site that I have created can be viewed at http://www.csdb.leeds.ac.uk/isynja/Main.html. The other files are accessed through the links on the main page. If the site is being viewed through the disk version, the file Main.html should be viewed, and the other files will be accessed in a similar way.

5.2 The design of the prototypes

The site was edited in Microsoft Front Page, with a large proportion of the html written myself, particularly for the use of the frames.

5.2.1 Overall changes to design

Upon entry to the site, the user is now presented with the option of following the link to the beginner’s version of the site, or the advanced (screenshot 2 in appendix E). This links to the appropriate page for each user.

The two prototypes have been edited in order to provide a level of information more appropriate to the selection of beginner / advanced, by the user. Various aspects of the interface of the system have been altered, to improve the readability and navigation of the system. With the use of frames, an index has been included in both (see screenshot 3 in appendix E) so that the user can navigate through the page by selecting the sections relevant to their needs, rather than scrolling through the entire page. This requirement was explicitly identified by the learners, and is recommended in Kemp et al (1998). This index has been numbered, as Meyer (1985) (in Kemp et al) identifies that “explicit signals” concerning the amount of information that the learner has encountered and that remain, contributes to improved learning. This has also been employed in the text, wherever possible. In both prototypes, the font size was increased, as this results in the text being easier to read, and less of a strain on the eyes.
A table was also employed in the section “developing a methodology” (see screenshot 4 in Appendix E). This was employed as an alternative to the text that was previously in place, and offers a break in the text, as well as a more illustrative method of conveying the information. In the main text, the volume of words that were emboldened or italicised was increased, to illustrate the important points to the learner. These “typographical variations” (Kemp et al 1998) will also maintain the learner’s concentration. The globe images from the right and left hand columns were also removed, as they were an unnecessary feature, and if nothing else, made it more difficult to read the page, as they may distract the user’s eyes. Both features can be seen in the screenshots in Appendix D. The reasons for the inclusion of a mock email address at the end of the pages are two-fold (see screenshot 5 in appendix E). This is exercising user-centred design, by essentially making sure that the users are constantly testing the site, and so improvements could be made based on the input from the users. It was also included as a learning exercise for the user – even if the user did not construct a reply, it would hopefully make then think about how they used this site and if they found any problems with it.

For both versions, the screenshots illustrate aesthetic alterations made, in order to examine the changes to content, the site must be visited.

5.2.2 Specific changes to the “beginner” version

This version of the site is aimed at learners who require an introduction to the principles of user centred web design. It is not aimed as a practical guide for the implementation of a web site. It was decided that if the student was unfamiliar with the subject content of this page, it would be more beneficial to them if their version of the page was more concise. This was a requirement identified in the questionnaires by the learners studied (specifically, those who were not familiar with UCD theory), as they found the material very long. If a learner is unfamiliar with a topic, it is important that they do not become bored when reading the material, as they will not take the information in if they are not paying attention to it. Therefore the beginners are provided with an introduction to the topic.

The site concludes with a version of the “Iterative Waterfall Model”, with the involvement of the users added at the appropriate stages (see screenshot 6 in appendix E). This acts as a summary of the page, as well as uses a pictorial representation of the information, which is more effective at illustrating information, that a textual description (Kemp et al 1998).

5.2.3 Specific changes to the “advanced” version

The advanced section was more difficult to edit, as the initial site was fairly comprehensive in its description of user centred web design. It is assumed that the learner for this site is familiar with basic system development terminology and so the content has been changed so that some definitions
that an advanced learner would be aware of, have been removed, such as “requirements specification”. This is so the advanced learner does not have to read unnecessary material. As opposed to the learner version of the site – this could be used as practical advice for designers who are planning to implement a web site with the involvement of their users.

5.3 Conclusion

The aim of this chapter was to implement some of the findings of the questionnaires (see section 4.4.5) to illustrate the benefits of consulting the users when designing an adaptive e-learning web site. This has been achieved by the addition of an index to both versions of the page. The aim was also to illustrate the benefits of an adaptive site, by producing a version of the Napier site to accommodate two levels of user knowledge. This was achieved by editing the content of the site to produce a site for beginners and advanced users.
Chapter 6 - Conclusion and evaluation

6.1 Conclusion

The aim of this project was to illustrate that the theories of User Centred Design could be applied to the design and implementation of an adaptive e-learning site, and through research and an empirical study, the feasibility of this concept has been explored.

Research regarding User Centred Design has illustrated the advantages of involving the users of an e-learning system in its development. The designers must be continually reminded that the system is being developed for the use of the users. If the users are involved in every stage of development, the site will incorporate their needs, preferences and capabilities, resulting in an effective learning tool. The problems of such user involvement have also been discussed, and an attempt has been made to advise on minimising the disadvantages. Research on adaptive e-learning has illustrated the characteristics possessed by such systems, and how this also aids learning.

The findings from the research have combined to produce a set of guidelines to aid designers in the development of an adaptive e-learning site. The guidelines advise to involve the users (both learners and teachers) at every stage of the development, in order to develop accurate requirements, implement an effective system, test the prototypes before the final site is launched, and continually act on feedback. The difficulty of identifying learners and gaining their input is noted.

The guidelines have been verified with a questionnaire study, in which the teachers, and learners familiar with UCD illustrated a willingness to be involved in the development. Most learners also stated that they would participate in online tests to aid their learning, and some (mainly the Information Systems contingent) expressed their faith in an adaptive system, and that they would be prepared to provide information in order to use this facility.

The questionnaires also questioned the users of an e-learning web site in its redesign. The requirements for the “User Centred Web Design” site that were identified in the questionnaires were implemented as part of the modifications to the site. The main requirement identified in the questionnaires was the addition of an index to aid the navigation of the site. Research was also carried out in order to further modify the web site, and this yielded such features as the addition of illustrations and the alterations to the “typography” to aid the learner. The third phase of the guidelines was therefore carried out, as this site acted as a form of prototype for evaluation.

Overall, the project shows that the application of UCD to adaptive e-learning is possible, and would yield the benefits sought. Research has however shown that problems will arise, in particular when locating the users, and convincing them to become involved, and the low questionnaire response from the learners also illustrates a lack of willingness to participate.
6.2 Evaluation

The following objectives were identified at the commencement of this project, and a criteria has been applied to establish their successful completion.

Theoretical Objectives

Objective 1: To gain an understanding of the terms User Centred Design, adaptivity and web based e-learning, and to identify how the three areas can be related to produce an effective tool for learning.

1. Were the terms defined?
   
   This is an essential part of studying a topic, and forms a basis for further investigation.
   
   A clear definition of each term was provided in the relevant chapters.

2. Were the terms elaborated upon, showing a clear understanding of their meaning?
   
   This is important in producing a comprehensive survey of the areas involved.
   
   Research was undertaken for each term, resulting in a detailed description of the three terms, illustrating that understanding of the terms was obtained.

3. Were the three areas related together?
   
   This is required, in order to relate the terms given to the project.
   
   The benefits of User Centred Design and adaptivity in the use of online e-learning tools were identified.

Objective 2: To identify how theories on User Centred Design can be applied to the design of web based e-learning sites, by the creation of guidelines detailing how the design of such sites could be improved by the use of User Centred Design.

1. Was a narrative description illustrating why User Centred Design can produce an effective adaptive e-learning tool provided?
   
   This is necessary in order to illustrate that the findings of the research can be related to produce an effective e-learning tool.
   
   The applicability of User Centred Design to the development of adaptive e-learning tools was illustrated, specifically why this can improve this kind of system.

2. Was detail given of how the theory of User Centred Design can be applied to adaptive e-learning – i.e. did the guidelines provide a comprehensive description of how this can be achieved?
   
   This is required in order to illustrate that the findings of the study can be realistically applied to a real life situation.
   
   The guidelines produced provided a step by step guide to developing an adaptive web based e-learning tool with the use of user centred design, which could be carried out in a real life e-learning project.
3. Were any problems with this approach identified?

*This will illustrate a realistic approach to the subject, acknowledging that any approach is not infallible.*

Problems such as user identification and unwillingness to be involved were acknowledged, and possible solutions were provided.

**Practical objectives**

Objective 3: To survey users of a current web-based e-learning site, to gain their perspectives on which aspects of the site could be improved, and what contributes to an effective, adaptive web-based e-learning site, in terms of providing the correct information, and accessing that information effectively.

1. Was an appropriate site identified?

*This is to ensure that the information provided was useful and could be used to improve the site.*

The site was a fairly basic e-learning tool – it contained no adaptive features and was a simple narrative description of the subject. It was aimed at the correct level for the students involved, and was easily accessible to them. It was also concurrent with the subject matter of the project, which aided the content editing.

2. Were the users surveyed appropriate?

*This is to ensure that the information provided by the questionnaires was reliable.*

The users surveyed were learners who would learn from such a site, and teachers who had experience in developing e-learning material, and so each provided details of their own perspective.

3. Was information obtained regarding improvements to the site?

*This is to ensure that the release of the questionnaires served the purpose that was intended.*

The learners provided some information regarding the shortcomings of the site, however less information was extracted than was hoped.

4. Were opinions on what constitutes an effective learning tool provided?

*This is also to ensure that the release of the questionnaires was not futile.*

Information was obtained concerning the implementation of effective e-learning tools from the teacher contingent. The learners also provided preferences regarding e-learning.

Objective 4: To study these results and implement the guidelines to design and produce an improved version of the site studied.

1. Were the results studied and conclusions drawn from them?

*This is to ensure that the results are used in an appropriate way.*

If any patterns in the results emerged, conclusions were drawn from this.

2. Were the results applied to the design of the new version of the web site?
This is to ensure that the results from the questionnaires were applied to this study. This occurred where possible, however the questionnaire results did not yield a great deal of information that could be used in the re-design of the site. To compensate for this, research was carried out in order to improve the site.

3. Were the guidelines implemented?
This is to verify that the guidelines produced can be realistically implemented. The guidelines could not be fully implemented, due to time constraints involved in the project. However, the third phase was carried out, as the learners of the site performed a testing role on the web site, and the response provided a basis for some of the re-design.

4. Was the version produced an improvement on the original?
This is to determine the successful implementation of the guidelines. The new version of the site offers features desired by the users, identified in the questionnaires. The content was changed, in accordance with the provision of a “beginner” and an “advanced” version. A primitive example of adaptivity is provided, which was strongly identified as a positive feature by the teachers and learners in the questionnaire study. The site also employs improvements in the presentation of the information, as identified in the research undertaken.

6.3 Evaluation of the schedule
The schedule produced in the mid project report was not adhered to as closely as was hoped, due to an overestimation of what was possible in the time given. The milestones were achieved in the correct order, and the project was completed in the time required, however not in accordance with the original schedule. This was due to the fact that the research phase took longer than expected and initial progress was slow as much redundant material was studied in an effort to clarify the scope of the project. However the final three phases took less time than I had originally anticipated which is mainly due to the change in the final minimum requirement, from producing an e-learning site, to editing an existing one, which made the schedule more realistic.

6.4 Overall verdict
The overall objective of the project was to explore the possibility that User Centred Design could be applied to the development of adaptive web based e-learning tools. This has been realised by gaining an understanding of the terms involved, and how they can be combined to produce an effective learning tool by implementing the guidelines created. The guidelines have not been verified to the extent that would have been desired, which is due to a lack of time to test them fully in practice.
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Appendix A

When faced with the problem of considering the area in which to conduct my Final Year Project, a number of areas of study interested me, and after much deliberation I decided to pursue the subject of adaptivity in e-learning.

The evolution of the title of this project is illustrative of the learning that I have experienced, however this meant that I conducted a large volume of redundant research in the early stages of my project. This research did contribute to my overall understanding, particularly in the area of adaptivity, adaptability and personalisation. The term e-learning was used in preference to “e -training” as the materials studied in this project were tools providing information, as opposed to tools that taught learners a particular skill. The phrase web -based was used in order to differentiate from other electronic means of learning, for example on CD-ROM.

When the project began, an overestimation of what was achievable in the given time took place. In particular the research phase was extremely time consuming and laborious. However I recognised that the minimum requirements would need to be changed, and the amendment of a current web site seemed an ideal solution, as it would not be possible to create a web site “from scratch” as was hoped.

An important lesson that I have learned when conducting this project is when to stop. This is particularly applicable to the research phase, as the volume of material available is vast, and so a skill of deciding what to include has been acquired. It is also important to realise when to stop when it comes to editing the report – there are many different ways to phrase the same sentence, and agonising over the most appropriate has cost me a large amount of time.

One of the aspects of the project that I have found the most difficult has been adhering to the project schedule. When I composed the original version, I did not anticipate the amount of time required for my research, which had a knock-on effect to the rest of my project. I attempted to compensate for this by writing my research chapters as the research was carried out. This seemed like a good idea, especially with colleagues reporting that they “had done all of their research, but still had it to write up” as the deadline approached. Other commitments such as coursework and exam revision were also substantial factors in the failure to adhere to the original schedule, and I would strongly advise future students carrying out a similar project to consider these factors. If the time was available (for example if this was a larger project) I would have most definitely liked to have liked to implement all of the guidelines that I produced.
In hindsight I would have also implemented the questionnaires differently. Incentives would have been provided, possibly a prize draw for a small sum of money. This subject did arise after the release of the questionnaires, but I did not feel that I was in a position to offer an incentive to every recipient, but in retrospect, a prize draw would have been a good solution. I would have also made an inquiry into the likelihood of learners using a feedback facility, however I found it difficult to design the questionnaires to be 100% concurrent with the guidelines, due to the fact that they were produced in unison, and as the questionnaires were released, the recommendations were not completely finalised. This would have been rectified by a clearer statement of objectives on my part. As previously stated, I would have also liked to have released a questionnaire concerning the website that I had produced, which would have acted as a usability test, however it was soon realised that this was beyond the scope of this project.

Recommendations for further study
- A greater focus on the user modelling aspect of this project.
- Further testing of the guidelines with case scenarios.
- Further adaptive features in the web site.
- A comparison of performance of students using different forms of adaptivity.
- The implementation of a more comprehensive assessment.
- A further investigation into the other factors contributing to the development of an effective e-learning tool, particularly cognitive psychology, Human-Computer Interaction, Communication theory, Information Design, and Instructional Design.

A surprising element to this project was the correspondence that I entered into with members of the academic community, who were extremely helpful and interested in my project.

My overall opinion on the experience of this project as that it has been a huge challenge for me, and I have learnt many lessons from it, in particular the importance of planning realistically, and the need for justification. I feel I have learned a great deal, as not only have I gain knowledge concerning the subject area of the project, but also time management and organisation.
Appendix D

Teachers questionnaire

I am attempting to assess the impact of involving the users in the design of an adaptive web-based e-learning systems, i.e. e-learning systems that understand the needs, requirements, knowledge, expectations, etc. of their users and tailor the instruction to each individual. In my final year project at the School of Computing, Leeds University, I am investigating the application of User centred design to the implementation of adaptive e-learning systems. User centred design requires that users are involved during different phases of software development.

I am interested in your perspective as a teacher who may design or use e-learning materials in their courses. You may provide the knowledge required for the content of such systems, and advise on the features that you would require for such tasks as online assessment, monitoring student use of the site, and editing the content. I am therefore interested in any experience you may have in this field.

Should you require an example of an online tutoring system, http://www.dcs.napier.ac.uk/~mm/im/tutorial/userwebdesign.html may be of help. If you have any questions at all on completing this questionnaire, please do not hesitate to contact me at either isynja@comp.leeds.ac.uk or nics87@hotmail.com. I will be available to receive emails over the Easter period if necessary.

Please mark your preference with an X to the left hand side of the option, or write your comments where necessary.

Thank you very much for your time, and your assistance is greatly appreciated.

Section 1

Adaptive web-based e-training systems:

1. As a teacher, would you say that your motivation is to provide as many students as possible with the knowledge that you possess and have access to?
   Yes
   No
2. Have you ever played a part in implementing an e-training system?
   Yes (if yes, please complete questions 3-7)
   No (if no, please complete questions 8-10)

3. Did this system provide any adaptive features, e.g. feedback to the student, different level of presenting the content, guidance, etc.?

4. Could you please attempt to explain your motivations for becoming involved in such a system?

5. Did you feel that the performance of your students was enhanced by the use of such systems (compared to those who did not take advantage of the facilities)?
   Yes
   No

   Can you provide any reasons for why you think this is?

6. How would you describe the involvement that you had in the development of the system? Please mark any statements that you feel apply to you:

   I provided the knowledge that was to be taught to the learners

   I provided some of the requirements for the teacher’s use of the system

   I provided some of the requirements for the learners of the system

   I was involved in the design on the interface that was to be used by the teachers

   I was involved in the design of the interface that was to be used by the learners

   I tested the prototypes for the system that was to be used by the teachers

   I tested the prototypes for the system that was to be used by the learners
Please provide any further details of your involvement:

7. Would you have preferred to be further involved in the design of the system(s)?

   Yes
   No, I was happy with the level of involvement that I had
   I would have preferred to be involved less

   Can you provide any reasons for this?

Please go to Section 2

8. Have you ever considered employing the use if a web-based system to aid your teaching?

   Yes
   No

   Could you please give an explanation for this (e.g. never thought about it, considered it but decided against it, or was unable due to factors beyond your control)

9. Have you ever considered employing a form of online assessment?

   Yes
   No
Could you please give an explanation for this (e.g. never thought about it, considered it but decided against it, or was unable due to factors beyond your control)

10. If you were to implement such a system, how far would you like to be involved in its design?
   Not at all
   I would prefer provide the material for the site
   I would prefer to have a small amount of input in the design of the interface
   I would prefer to be involved in the requirements gathering for the site
   I would prefer to be involved in the testing of prototypes
   I would prefer to be involved in every decision made by the designers

   Would you like to comment on any of the options selected above?

**Section 2**

1. What is your experience in User Centred Design:
   I have thorough knowledge of User Centred Design and have applied it
   I am familiar with the concepts of UCD but have not applied it
   I am only familiar with basic UCD concepts
   I have never come across User Centred Design

   Would you like to make any further comments on any of the questions asked, or answers you have provided above?

*Thank you very much for completing this questionnaire.*
Learners questionnaire

I am attempting to assess the impact of involving the learners in the design of adaptive web-based e-learning, i.e., e-learning systems that understand the needs, requirements, knowledge, expectations, etc. of their users and tailor the instruction to each individual. In my final year project at the School of Computing, Leeds University, I am investigating the application of User centred design to the implementation of adaptive e-learning systems. User centred design requires that users are involved during different phases of software development.

The aim of this questionnaire is to understand your perspective on adaptive e-learning systems and your willingness to participate into the design of a web based tutorial that will be used in a university module. As an example for this questionnaire, we will use an existing tutorial on User Centred Design:

http://www.dcs.napier.ac.uk/~mm/im/tutorial/userwebdesign.html

I hope to examine how this tutorial would be improved with the involvement of users during the design process.

Should you encounter any problems whatsoever whilst completing this questionnaire, please do not hesitate to contact me at either isynja@comp.leeds.ac.uk or nics87@hotmail.com. I will be available to receive emails over the Easter period if necessary.

Please mark your preference with an X to the left hand side of the option, or write your comments where necessary. If comments are requested, please answer as fully and clearly as possible.

Thank you very much for your time and assistance.

Section 1
Some general questions about your use of computers:

1. What is your degree programme (please type):

2. How much experience do you have with the use of computers?
   - I would consider my self to be very experienced
   - I am comfortable using a computer but am not an expert
   - I have only used them on a few occasions
   - I have never used a computer

3. How much experience do you have with the Internet?
I would consider myself to be very experienced in its use
I use it often but am not an expert
I have only used it a few times
I have never used the internet

4. How far would you agree with the following statements, on a scale of 1-5,
1 - strongly disagree
5 - strongly agree.

I find it difficult to familiarise myself with an interface
I prefer to browse a system myself, rather than be guided
I never use help sections
I often have trouble using a system, because it uses too many technical terms
I grow impatient when a system treats me as if I am stupid (e.g. gives unnecessary details, directs me to useless sources, etc.)
I prefer a system that allows me to change the way I use it

Section 2 – Your opinion on adaptive e-learning in general

Before reading the online tutorial could you please answer the following questions:

1. Have you ever used a web-based e-training tool before?
   Yes
   No
If yes, please specify if possible:

2. Do you think that completing small online tests would aid your learning of a particular topic (e.g. assessing your knowledge may help you find out what needs to be learnt)?
   Yes
   No
   Please comment if possible:

3. If such tests were available for your university modules, would you use this facility?
Yes
No

If no, why not, and what might make you change your opinion, if anything?

4. Would you like a system to change the information that it provides you, in accordance to what it thinks you should view (based on your knowledge and performance in online tests)?
   Yes
   No

Please comment - if no, why not, if yes- what kind of changes would you like?

**Section 3 - Using an adaptive web-based e-training system**

1. What is your knowledge in User Centred Design:
   I have thorough knowledge of User Centred Design and have applied it
   I am familiar with the concepts of UCD but have not applied it
   I am only familiar with basic UCD concepts
   I have never come across User Centred Design

Please go through the material at the web site:
http://www.dcs.napier.ac.uk/~mm/im/tutorial/userwebdesign.html

Please familiarise yourself with basic concepts of UCD.

2. Did you feel that the use of this site enhanced your learning experience (e.g. when compared with reading the material in a book)?
   Yes
   No

Please comment if possible:

2. Please state how far you agree with the following phrases, on a scale of 1-5,
   1 - strongly disagree
   5 - strongly agree.
I got bored when reading the material
I did not understand the material
I possessed enough skill in computers to navigate the tutorial successfully
I didn’t mind having to scroll through the whole material to find a topic that I was interested in
I found the display made it difficult to read the information
I found aspects of the display annoying
I found a lot of the information provided to be irrelevant
I felt that I learnt a lot from reading this material

Would you like to comment on any of these statements?

3. Would you have objected to providing information about yourself (your preferences, objectives and level of background knowledge) before reading the material?
   Yes
   No

   Could you please attempt to explain your answer?

4. Do you feel that your learning would have been enhanced by the completion of a short test at the end of the page?
   Yes
   No

   Could you please attempt to explain your answer?

5. Would your answers to questions 3 and 4 change if you knew that this information would be used by the system to adapt the content to your perceived needs?
   Yes
   No
Could you please attempt to explain your answer

6. Do you think that the site could have been improved with your input, where interface design and content are concerned?

Yes
No

Could you please attempt to elaborate?

7. Would you have taken part in any of the following, if given the opportunity (please select):
   Completing a questionnaire concerning your requirements for this site
   Participating in focus groups designing the interface and content of the site (e.g. organised by school of computing lecturers)
   Examining prototypes of the site remotely (e.g. with the use of screen shots, via email)
   Completing testing of prototypes of the system in person

Could you please explain your reasons for being willing/unwilling to participate in any of the above?

Are there any further comments you would like to make on the above questions, or the subject of user centred design and/or adaptive web based e-training?

Thank you very much for completing this questionnaire