The candidate confirms that the work submitted is their own and the appropriate credit has been given where reference has been made to the work of others.

I understand that failure to attribute material which is obtained from another source may be considered as plagiarism.

(Signature of student) ________________________________
Summary

The primary objective of this project was to design an interactive computer based system, called Ronny's Den, which would aid the learning and teaching of educationally disadvantaged children at the Leeds Rhinos Rugby Club Study Support Centre. Research was carried out to find what was currently available to disadvantaged children in the form of computer based study support and the benefits this offered. Focus groups and semi-structured interviews with sample users from the rugby club, combined with reviews of current teaching methods were used to identify user needs and requirements. Ronny's Den was then designed to meet these requirements and a prototype offering basic functionality was developed. The prototype was evaluated against user satisfaction and usability criteria.

The following was achieved in this project:

- Research of existing ICT solutions for disadvantaged children.
- Review of appropriate methodologies and choosing of an appropriate methodology for this project.
- Identifying user needs and system requirements based on empirical study, including focus groups, semi structured interviews and document reviews.
- Design of Ronny's Den based on identified requirements through iterative design and user focus groups.
- Implementation of a prototype for Ronny's Den using MySQL and PHP to demonstrate basic functionality: user login, weekly session planning, multiple choice and short answer questions for a selection of worksheets, a math test and student progress reporting.
- User and heuristic evaluation of the prototype.

The project was effectively managed throughout all milestones and deliverables have been completed.

The implementation of Ronny's Den that was evaluated by sample users from the Rugby Club is available to view at http://www.burtie.co.uk/lrrcss/fyp/ using the username cburton and password cburton to login.
Acknowledgements

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 Dr. Vania Dimitrova, who provided me with guidance and support throughout.

I would also like to thank the staff and students from the Leeds Rhinos Rugby Club Study Support Centre who took the time to participate in focus groups, interviews and testing. Also the individuals who provided me with additional information regarding the project.

Finally, I would like to thank my family and friends for their endless tolerance and support.
The Design and Development of Educational Software for Disadvantaged Children.

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Chapter 1: Introduction

1.1 Problem Definition

There is an increasing use of computers in education and this has led to the development of various computer based learning systems (Hall, 2001). An area that this has developed with is aiding disabled children in education (Janicki, 2003). However, the area of “reluctant learners”, children who struggle in school due to other, non-physical disadvantages, e.g. poverty, or social exclusion, is not as well represented with appropriate computing based learning packages (Sitko, 1996).

Children who are disadvantaged by poverty, unstable environment or poor education will often under perform at school and may have some behavioural problems later in life (Boyd, 1999). One way to deal with such students is to build communities where students are engaged in enjoyable activities (e.g. sports, crafts and arts) that are combined with learning activities. These schemes are able to intensify motivation and improve learning for the children¹. An example of such community project is the Study Support Centre held at the Leeds Rhinos Rugby Club. Although the use of ICT software is encouraged, these centres often use standard applications that are not specifically designed for the users at the centres.

Leeds Rhinos Rugby Club Study Support Centre offers an after school club for children who are disadvantaged and struggle with academic work, with the goal of improving their Maths, English, ICT, communication and team working skills. Although they currently have a well-equipped computing lab, much of the current software is of limited use to the children, and is not relevant to the work taught at the centre. Standard application packages, such as Microsoft Office are currently used, offering limited integration with the course taught at the centre.

1.2 Project Aim

The aim of the project is to research the application of Human Computer Interaction (HCI), user-centred design to the design of educational software for disadvantaged children. A holistic approach will be undertaken whereby users and the designer work together to produce software that complies with the social environment the children are working in and with their educational needs. This will be illustrated with the design of a sample system. A prototype with the basic functionality of the system will be developed.

¹ Community Programs Mission Statement: http://www.communityprogrammes.org.uk/cgfl/contacts/
1.3 **Project Objectives**

The objectives for this project are:

1. Choose design methodology that complies with the user centred design requirements and the specifics of this project.
2. Devise initial requirements.
3. Design a system for disadvantaged children from the Leeds Rhinos Support Centre.
4. Produce a prototype for the system.
5. Evaluate the prototype using appropriate HCI evaluation techniques.

1.4 **Minimum Requirements and Useful Extensions**

The minimum requirements for this project that will be used for evaluation purposes:

1. Research existing ICT solutions for disadvantaged children.
2. Review of user centred design technologies to identify how they can be used for designing educational software for disadvantaged children.
3. Based on an empirical study, including semi structured interviews and focus groups as appropriate, identify the user needs and produce requirements.
4. Design a system for Leeds Rhinos Support Centre following appropriate methods.
5. Develop a prototype to include the basic functionality of the system.

There are some possible extensions to the project that may be undertaken with time permitting. These extensions are:

1. Development of full system to include further subject areas.
2. Evaluation of full system.

1.5 **Deliverables**

The deliverables for this project are:

1. Project report.
2. A prototype for the system to include basic functionality.

1.6 **Project Schedule and Revisions to Schedule**

Show in figure 1.1 is the summary for the project schedule. Included in Appendix B is the Gantt chart for this original project schedule. Most of the activities ran to schedule, however, some tasks later on in the schedule were affected by delays in meetings with the users at the rugby club, for interviews and focus groups. This had a knock on effect to some of the other activities. Also, the iterative design technique used during the design and prototyping stage meant that the prototype was being developed into a larger functioning system at the same time. Because of this, “Full System Design” has been removed from the revised schedule,
below, and has been included with the prototyping design and evaluation. A revised schedule was made to accommodate the changes. This is shown below in figure 1.2

<table>
<thead>
<tr>
<th>No.</th>
<th>Dates</th>
<th>Activity/Objective</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13/10/03 – 20/10/03</td>
<td>Identify aims, objectives and minimum requirements</td>
<td>Specify aims, objectives and minimum requirements</td>
</tr>
<tr>
<td>2</td>
<td>20/10/03 – 10/10/03</td>
<td>Review methodologies and user centered design techniques.</td>
<td>Section on Methodologies</td>
</tr>
<tr>
<td>3</td>
<td>27/10/03 – 24/11/03</td>
<td>Review existing ICT solutions for disadvantaged children.</td>
<td>Section of current use of ICT in this field.</td>
</tr>
<tr>
<td>4</td>
<td>17/11/03 – 01/12/03</td>
<td>Prepare Focus group material and semi structured interviews</td>
<td>Focus group plan</td>
</tr>
<tr>
<td>5</td>
<td>01/12/03 – 22/12/03</td>
<td>Initial focus groups and semi structured interviews with children from Leeds Rhinos</td>
<td>Specify User Requirements and software requirements with design ideas.</td>
</tr>
<tr>
<td>6</td>
<td>15/12/03 – 22/12/03</td>
<td>Identify specific characteristics of ICT solutions for chosen subject at Leeds Rhinos.</td>
<td>Complete section of ICT within education (3)</td>
</tr>
<tr>
<td>7</td>
<td>22/12/03 – 22/01/04</td>
<td>Break up for Xmas and Semester One Exam period</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>23/01/04 – 16/02/04</td>
<td>Design appropriate system using an iterative approach with the users.</td>
<td>System Design</td>
</tr>
<tr>
<td>9</td>
<td>16/02/04 – 05/03/04</td>
<td>Prepare draft chapter and contents page for approval.</td>
<td>Draft chapter and contents page for supervisor</td>
</tr>
<tr>
<td>10</td>
<td>16/02/04 – 08/03/04</td>
<td>Create Prototype for system</td>
<td>System Prototype</td>
</tr>
<tr>
<td>11</td>
<td>08/03/04 – 22/03/04</td>
<td>Evaluate Prototype</td>
<td>Prototype Evaluation section.</td>
</tr>
<tr>
<td>12</td>
<td>15/03/04 – 19/03/04</td>
<td>Prepare and have Progress Meeting</td>
<td>Meeting with Supervisor/Assessor</td>
</tr>
<tr>
<td>13</td>
<td>22/03/04 – 12/04/04</td>
<td>Create working system</td>
<td>Working system produced</td>
</tr>
<tr>
<td>14</td>
<td>12/04/04 – 19/04/04</td>
<td>Evaluate working system</td>
<td>System Evaluation</td>
</tr>
<tr>
<td>15</td>
<td>12/04/04 – 28/04/04</td>
<td>Complete Report and Project Evaluation</td>
<td>Report complete</td>
</tr>
</tbody>
</table>

*Figure 1.1: Original project schedule highlighting main stages and milestones. Gantt chart for this schedule is available in Appendix B.*
<table>
<thead>
<tr>
<th>No.</th>
<th>Dates</th>
<th>Activity/Objective</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>23/01/04 – 30/01/04</td>
<td>Requirements gathering and user focus groups.</td>
<td>System requirements identified</td>
</tr>
<tr>
<td>9</td>
<td>30/01/04 – 21/02/04</td>
<td>Design appropriate system using an iterative approach with the users.</td>
<td>System Design</td>
</tr>
<tr>
<td>10</td>
<td>16/02/04 – 05/03/04</td>
<td>Prepare draft chapter and contents page for approval.</td>
<td>Draft chapter and contents page for supervisor</td>
</tr>
<tr>
<td>11</td>
<td>21/02/04 – 22/03/04</td>
<td>Create Prototype for system with extended features</td>
<td>System Prototype – fully working</td>
</tr>
<tr>
<td>12</td>
<td>15/03/04 – 19/03/04</td>
<td>Prepare and have Progress Meeting</td>
<td>Meeting with Supervisor/Assessor</td>
</tr>
<tr>
<td>13</td>
<td>22/03/04 – 29/03/04</td>
<td>Evaluate Prototype and System functionality</td>
<td>Prototype Evaluation section.</td>
</tr>
<tr>
<td>14</td>
<td>30/03/04 – 28/04/04</td>
<td>Complete Report and Project Evaluation</td>
<td>Report complete</td>
</tr>
</tbody>
</table>

**Figure 1.2:** Revisions undertaken upon the original project schedule presented in figure 1.1.

### 1.7 Relevance to Degree Programme and Previous Knowledge

This project draws from knowledge gained through several modules taken by the developer whilst at the University of Leeds; the methodologies reviewed have been chosen based on information systems and project management modules (IS21, IS33, SO22); requirements gathering techniques and user needs analysis have been covered during project management and object orientated analysis and design (SO22, IS21); technical design and implementation issues have been covered during distributed systems, internet technologies and advanced databases (SY33, IN24, IN23, DB21, DB31); prototyping and user interaction techniques have been covered during human computer interaction and project management modules (SY13, SO22).

### 1.8 Summary

The problem definition has been introduced and minimum requirements have been identified. A plan for project schedule, with milestones identified has also been produced. A literature review will be undertaken to research the background to the problem to ensure the users, current solutions and requirements are identified; this will use a combination of books, journals and web resources. A methodology for the project will be chosen and followed throughout the project schedule. Requirements will be gathered and a design produced based in these findings. Finally, a prototype will be developed and evaluated.
Chapter 2: Computer Based Learning for Disadvantaged Children

Computers have been used in the classroom since the 1960s, however these were only available to the minority and offered little in the way of educational support (Scanlon et al., 1987). With computing equipment becoming widely available and more accessible to the majority of users, use in schools has also increased with many subjects now utilising the advantages they have to offer (Hall, 2001).

For the purpose of this project, target users need to be identified and a review of how current computer based learning systems relate to them. In this section the application of computer based learning systems within the educational environment, the benefits they have to offer and whether these could be carried over to use with disadvantaged children at the rugby club will be reviewed.

2.1 Disadvantaged Children

The term ‘disadvantaged children’ covers a wide range of children with a variety of problems. The term often refers to mental and health disabilities or to children from developing countries (Boyd, 1999). For the scope of this project it is important to constrain the definition, as there isn’t sufficient time or resources to look at all areas. For the users of this system, the term principally refers to children who are economically or socially disadvantaged as this has been linked to an increase in child morbidity which includes emotional, social and educational health deficits (Lipman et al., 1994). The actual disadvantage this project will be looking at is not just a matter of money or lack of, but extends to the environment in which a child grows up which includes characteristics of the: family, neighbourhood, school availability and recreational facilities.

Lipman et al (1994) cite that children with these disadvantages will often suffer from poorer school readiness, low maths concept skills, poor communications and team working skills. This demonstrates that children who are disadvantaged in this way will often have different educational requirements than those who are not.

In March 2003, the UK Government agreed to fund £435 million for the development of educational centres for children in disadvantaged communities. Although funding is aimed at children younger than five, the government recognise the problem of disadvantaged children

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2 Canadian based organisation looking at disadvantaged children and study support: www.hc-sc.gc.ca
3 Department for Education, discuss the recent funding investments into study support centres. www.dfes.gov.uk
and is actively working to improve the education available to these communities.

There has also been recent funding, through the Excellence in Cities (EIC) scheme\(^4\) for school-based City Learning Centres (CLC). These are state-of-the-art ICT-based learning opportunities for the pupils including recording studios, computer-aided design equipment, video equipment, etc. These are made available to local schools and the community with emphasis on enhancing opportunity in disadvantaged areas\(^5\).

### 2.2 Disadvantaged Children at the Leeds Rhinos Rugby Club

As well as researching the area of disadvantaged children, it is also important to identify the specific user group at the rugby club that the system design is aimed towards. This will highlight key factors that are specific to the targeted user group that may effect the system requirements later on in the project.

The students who attend the Study Support Centre often come from fairly deprived areas within the city of Leeds. They have been identified by their teachers as students who could benefit from the work undertaken at the centre. Often, these students will struggle with schoolwork, have poor social and communication skills, have difficulty understanding problems and will have short concentration spans. This raises many issues that need to be considered during the design of a computer-based learning system for these users:

- Students may be easily distracted, so use of animation should be carefully considered.
- Poor problem-solving skills will affect the style and structure of tasks.
- Students may have low self-esteem and little confidence in their work and own ability; support in producing work of high standard is important.

### 2.3 Computer Based Learning Systems

The use and availability of computer based learning packages has drastically increased over the past few years with an increase in the use and accessibility of computing equipment\(^6\). The UK Government has recently established an ‘e-learning strategy’ to encourage the development of ICT use in learning\(^7\) which highlights the benefits ICT has to offer. The purpose of these systems is to provide an interactive learning approach within a given subject area. Computer Based Learning systems (CBL), offer many advantages to its users. Many CBL systems have the ability to adapt the content and complexity based on the students’

---


\(^5\) Policy for City Learning Centres. www.standards.dfes.gov.uk/excellence/policies/CLC/

\(^6\) Warwick University: Guide to CBL - www.warwick.ac.uk/ETS/Publications/Guides/cal.htm

\(^7\) UK Government E-Learning Strategy: http://www.dfes.gov.uk/elearningstrategy/
ability allowing students to progress at a pace they are comfortable with (Sitko, 1996). Computer based systems also offer the child an alternative to standard classroom based teaching methods such as worksheets. In the classroom, pupils enjoy a range of activities that offer a slightly different approach than the usual teaching pattern (McNicol, 2002). For example, the use of computer packages to perform a task instead of a written worksheet could be seen as more motivating to the child, especially if the package offers an interactive, multimedia approach to grab the child’s attention and interest (Phillips, 1997). However, research by McNicol (2002) has indicated that an excessive use of computing in education can have a counter productive effect with children become less motivated by ICT the more it is used. The more time a child spends using a computer often means less time working in groups and with others as many CBLs are designed for the individual to use. This can have an effect on the child’s communication and team working skills, which are also vital to a child’s education (McNicol, 2002).

The key area CBLs have been used for is to offer interactive multimedia to the child (Phillips, 1997). This is when information is displayed to the user using a variety of sources and not just text. A combination of text, pictures, animations, sounds and video can be used to ensure the material is suitably entertaining for the user and able to keep their attention for the duration of the task. CBLs are often interactive as they allow the user to take control of their learning experience by controlling the environment they are working with (Phillips, 1997). The key to interactive multimedia is that it allows a system or a task to accommodate various different learning styles and so can offer what appears to be a semi-personalised approach to learning for each individual as it is the individual who, to a certain extent is able to control their learning.

Computer based learning systems over the Internet are widely available however are not always designed with specific user groups, such as disadvantaged children – in mind. A web-based learning system is reviewed, highlighting key areas of concern and implications for systems developed in this project.

2.4 Current Web Based Learning Support

Web based learning systems specifically for disadvantaged children were not available at the time of this project; instead, a web based learning system for general use has been reviewed to highlight areas that are important to disadvantaged students. The site reviewed is http://www.bbc.co.uk/schools/gce bitesize/english/, which is a GCSE English revision aid. Although this is not the same learning situation as this project, there will be similarity between the functions available and the style, as both should aid learning.
The main points that will be looked at are the visual structure and design of the site. On first entering the site, the user is presented with several options; this would appear confusing to users specific to this project. All key navigational options are listed down the left side of the screen which makes navigational simple; navigation is done through images and buttons which could be visually appealing to the user by enhancing the page. The site is visually attractive with a wide range of colours, although use is consistent. Colour is used to separate and distinguish the various areas of the site.

2.5 **Implications for the Software Developed in this Project**

The users of the system have been identified as those that are disadvantaged as discussed in section 2.1. Disadvantaged children, as identified already, may have problems grasping areas such as maths and communications and a CBL system for these users will need to take this into account and will ensure that these factors are accommodated.

Many children who form part of this user group may have difficulty focusing on the problem or task they are set and will often have short concentration spans (Sitko 1996). This will need to be considered during the design and the final system should aim to increase a child’s concentrate span and keep them interested and focused on the task they are working on at the time for the duration of the task. This can be achieved by using a careful combination of multimedia and interaction methods. As was shown from the brief analysis of the Bitesize learning website, colour should be used to aid the users interaction by distinguishing separate areas of the site. Navigational factors are also important as could give the user a sense of confusion of the links are not always visible and intuitive.

2.6 **Summary**

The definition of disadvantaged children has been identified; it is these users that will be involved during the design and development of the project. These children come from economic or social deprived backgrounds. This will affect the way in which the child learns and hence the need to identify the unique learning requirements is important.

Computer based learning systems have been used to offer children an alternative learning method within the classroom but to also empower the child with their own learning by allowing them to control, with some limitations, their own learning environment. However it is important to ensure other areas such as communication and team working are not excluded with excessive use of CBL. A web based learning systems was briefly been analysed, and key benefits highlighted. Requirements and the needs of the specific user group this project focuses on will now be identified which will form the basis for system design.
Chapter 3: Methodology

The methodology will form an important part of the development of this project. The methodology is the collection of rules and guidelines that can be applied allowing the developer to work efficiently and effectively (Bergmann, 2002). Methodologies can vary greatly in the guidance they provide and therefore are not suited to every project. For this reason it is important that a suitable methodology is chosen at an early stage for the system development to make progress.

The system will be developed using a user centred approach and so this needs to be taken into account when evaluating the methodologies. Much of this project will be based around the initial stages of system development, analysis and design and so the methodology chosen must reflect this.

A selection of methodologies that cover both more traditional approaches and user centred approaches will be reviewed here. A methodology for this project, based on its compatibility with a user-centred design approach will be chosen.

3.1 User Centred Approach

To develop an effective computer based system, the user requirements, specification and domain need to be identified and considered during the development stages (Hammond & Trapp, 1992). For this reason it is important to involve the users during the project. This will help identify their needs and increase the likelihood that the system meets these requirements. Also, combined with continuous involvement and consultation with the user during development, acceptance by the users can also be increased (Gould et al., 1991). It is recognised that many systems lack the consideration for the user (Landauer, 1995) and that this can often lead to project failure as shown by the Standish Group in 1995\(^8\{8} where it was noted that misunderstanding user needs was the second most likely reason for failure.

User centred design focuses on the users’ needs being dominant in the design of the interface and functionality and it is this that should dominate the rest of the system (Norman, 1986). Gould and Lewis (1991) discuss the characteristics of user centred design in software development and highlight the key areas that need to be considered when involving the user to ensure that they are included in the correct way to achieve the best results. These are:

1. **Early focus on users:** Gould (1991) argues that it is important for designers to have direct contact with the intended or actual users via interviews, observations, surveys or participatory design.

2. **Continual user testing:** There should be an empirical approach to design where user feedback is carefully evaluated and testing is consistent.

3. **Iterative design:** The design of the system must be iterative to take into account any user feedback and suggestions made at earlier stages.

4. **Integrated design:** Finally, Gould discusses how all aspects of the design and usability should be designed together in parallel.

A user centred approach is important to this project as it:

1. Will allow the problems specific to the users of this system to be identified;
2. Will be able to gather information about the environment in the context of the children from the rugby club;
3. Will be able to address the needs specific to Leeds Rhinos Rugby Club by involving them in the project;
4. Can increase the children’s motivation and self-esteem, as they will see their views and opinions being valued and taken into account.

The methodology chosen for this project should allow for user-centred design to form part of the development cycle. Evaluation with users of the system, and user-based validation should be built in to all the stages of the design process, from the first prototypes until the pre-release stage (ISO 13 407).

### 3.2 Methodology Review

Methodologies reviewed here have been selected from methodologies studied by the developer through University in modules including IS21, IS33 and SO22. These methodologies are RAD, Waterfall and Interaction Lifecycle. First, the RAD methodology will be reviewed as it is most software engineering orientated approach looked at here; the interaction lifecycle is reviewed last as the most user based module review; the waterfall approach is looked at second offering both engineering and user aspects

#### 3.2.1: RAD Methodology

Rapid Applications Development (RAD) is a software engineering methodology and is used to minimise damage from user requirement change during a project and to allow the project to react quickly to these changes by involving the user in the design (Preece et al., 2002). Elliot (1997) describes RAD as having four key phases:

1. Requirements Planning: Joint Applications Development (user workshops)
2. User Design: Prototyping and user workshops
3. Construction: Prototyping and engineering
4. Cutover: Testing, evaluation and training

The emphasis in RAD is that larger projects be broken down into smaller, sub projects that allow for iteration and with each stage resulting in a further developed prototype while always including the users in the development. RAD focuses upon identifying the important users and involving them via workshops at early stages and although this covers the basic requirements this project requires from a methodology, the iteration and user involvement is limited to the first two stages within the lifecycle.

An approach that allows more user interaction is required so an alternative methodology will now be reviewed that offers more user interaction yet is still founded in software engineering.

3.2.2: Waterfall Methodology
The waterfall lifecycle was the first software engineering methodology proposed and so is well established within software development. It consists of five key stages: Analysis; Design; Implementation; Testing; Maintenance. Each stage must be completed before the next stage can commence although iteration to the previous stage is possible, which allows for some flexibility in the system development albeit limited (Bergmann, 2002). Unlike RAD, the waterfall lifecycle is not flexible enough to cope with requirement change, unless these changes arise in the initial phase. This means that user involvement is hard to incorporate, as the methodology itself is very stable and not flexible for change, suggestions and re-evaluation on a regular basis.

Another problem with the waterfall approach, when looking at the development of this particular system, is that we are primarily interested in the initial stages of development; analysis and design, while the waterfall approach looks at all five phases of the project in quite some detail which may not be suitable for this particular project.

Although waterfall offers greater user interaction than RAD, it is still not sufficient for this project. The next methodology is focused on user interaction yet still offers a structured approach to system development.

3.2.3: Interaction Lifecycle Model
The user interaction model incorporates key aspects from both of the previous methodologies discussed. The model consists of four key stages: identify the needs and requirements; design
and re-design; build interactive version (prototype); evaluate (Preece et al., 2002). These four phases are interlinked allowing for unlimited iterations between them. This results in a flexible methodology, as we are able to move freely between phases.

Another aspect to this methodology, which is limited in the previous methodologies, is that of user involvement. Like RAD, users are involved and this is the key to the development of the system. However unlike RAD, users are involved at all stages and not just the initial analysis and design stages. This encourages users to be included in evaluation and helps to identify problems and any missing requirements that need to be engineered into the system. The interaction lifecycle model is endless in the number of iterations that can be made to the system, except for constraints made by resources and time (Preece et al., 2002) and so can be ideal for projects of varying size including small ones like this project.

3.3 Chosen Methodology for this Project

After reviewing the above three methodologies, it is apparent that the interaction lifecycle model offers the most in terms of user involvement and iteration between phases which is a requirement if the intended users of the system are to be involved at all phases of the development. Because of this, the user interaction model will be used at the methodology for this project. Users will be included during the initial analysis and requirements stage but also through the design and prototyping stages through as many iterations time and resources will be appropriate to achieve a suitable system and to adhere to deadline constraints.

Now that a methodology has been chosen it is vital to ensure users involved and at the appropriate level. Sessions have been arranged with the Leeds Rhinos Rugby Club for the developer to work with two groups of children during the course of this project. A series of focus groups and semi-structured interviews will be used to gather information directly from the users. Once a prototype has been developed and made available to the test users, observations will be made, noting any problem areas.

3.4 Summary

Three key methodologies have been reviewed. The waterfall and RAD approaches, although offering many advantages, do not provide sufficient scope for user involvement. The interaction lifecycle model has been selected as it offers the most flexibility for a project of this type ensuring that users are involved at all stages.

Appropriate methods for requirements analysis will be employed, namely user focus groups and semi-structured interviews with staff and students from the Study Support centre.
Chapter 4: Needs Analysis and Requirements Gathering

In order to develop effective design requirements for Ronny’s Den, the requirements of the potential users (study support centre staff and the children who attend the centre) need to be gathered. In Chapter 3, methodologies for this project were discussed with the user interaction model being selected as the most appropriate. The importance of user involvement was also discussed, and it is here, at the needs analysis and requirements gathering stage where the users are initially involved. In this chapter, methods of requirements gathering will be discussed, and the results from the needs analysis sessions undertaken will be presented. Finally, a set of essential and desirable functional and non-functional requirements will be produced to inform the system design.

In a learning system, there are two main user groups: the teachers and the learners. In the Ronny’s Den system, the user groups will be the staff at the centre and the students who will be using the system during their time with the club. Potentially, the students will possess different requirements for the system based on their previous experience, ability and personal situation. However, the staff at the centre are likely to have similar experiences within their involvement with the centre and therefore have similar requirements. To cater for the difference in requirements different procedures of needs analysis for each group have to be undertaken. Staff, who are likely to have detailed and similar requirements, will need a semi-structured approach to requirements gathering whereas the students, who will have a greater diversity of needs, will require a less structured and more informal approach to ensure that all routes are followed.

4.1 Needs Analysis and Requirements Gathering Techniques

Preece et al (2002) refers to user needs as the understanding of the users, their capabilities, current tasks, goals and the conditions under which the system will finally be used. Once all of these are understood, requirements for the system can be identified which will form the basis of the system design. However, due to the iterative nature of the interaction lifecycle methodology, the design will often, as with this system, be intertwined with the requirements gathering stages through prototyping and focus groups, allowing the system to evolve.

To accommodate the different users and their needs it is important to use suitable data gathering techniques. Techniques that could be used for this project are questionnaires, interviews, focus groups, workshops, observations and studying current documentation. As discussed above, the project focuses on two user groups, staff and students. Questionnaires are good at getting many opinions back quickly but they do require the problem to be
understood from the beginning, for the questionnaire to generate any useful information. Interviews are generally one to one and can be good at exploring a specific problem area. By using semi-structured interviews, the interviewer is able to change the course of the interview based on user response. Interviews are appropriate when dealing with smaller user groups as conducting and analysing interviews can be time consuming. If prepared properly, interviews can generate many user needs and requirements. Semi structured interviews will be used with the main staff at the study support centre to gain information about their specific requirements. Group Interviews, or so-called focus groups, are suitable for dealing with groups of users instead of one-to-to discussions (Krueger, 2000). They are appropriate when the user group involved has varying opinions and some discussion between users has to take place. Focus groups highlight areas of agreement and disagreement (Preece et al, 2002). Therefore, focus groups will be used with the students at the rugby club to gather general user requirements for the system as well as requirements specific to the disadvantaged nature of the users. Furthermore, as a positive side effect of group discussions, one may envisage improved self-esteem and motivation and better communication skills, which have been identified as critical for disadvantaged children (see Chapter 2).

4.2 Student Focus Groups

4.2.1: Objectives

1. To establish problems with the current paper based worksheet approach.
2. To identify specific user needs for disadvantaged children at the centre.
3. To establish the systems visual and physical design requirements.
4. To identify features and tools students would like the system to include and why.

4.2.2: Participants

The centre has approximately one hundred and sixty students in attendance for each ten-week course. These comprise of eighty 9-11 year olds and eighty 13-15 year olds. A limitation on time and availability of the user groups restricted the number of participants that could be involved. A relatively large focus group of sixteen students was held as opposed to smaller groups as recommended in Nielsen (1996). This was to accommodate all users within the time restriction of one-hour. The group included students from the Monday 13-15 age group from two different secondary schools; not all students knew each other before the focus group.

4.2.3: Procedures and Materials

For the purposes of initial requirements gathering, a one-hour focus group was held. Further focus groups were used at later stages in the project to refine the design of the system (see Chapter 7). The focus group was designed based on recommendations by Nielsen (1996) and
Krueger (2000). In order to stimulate the user’s thoughts, paper based sketches for the system were used and later developed by the students (Nielsen, 1996). The focus groups were planned to give the impression of a free-flowing discussion and relatively un-structured feel as this would encourage the students to contribute their own opinions and thoughts instead of simply stating what they feel is the ‘correct’ answer. The focus groups were actually structured and controlled by the moderator to ensure that the objectives of the session were met and requirements gathered.

4.2.4: Results

Due to the large size of the group, recording the results was not an easy task. Nevertheless sketches produced during the session and notes based on students’ comments were taken and have been included in the Appendix (see Appendix D).

The majority of students agreed that they enjoyed using the computers and found them a more interesting alternative to standard paper worksheets. All students in the group were familiar with the Internet and websites and had successfully used Microsoft Internet Explorer before.

All students commented that they frequently found paper-based worksheets dull and that the main reasons were:

- They are not visual appealing, often black and white photocopies;
- Are very formulaic and provide little scope for exploring the tasks in more detail if the students wish to;
- Are often either too easy or too complicated making it difficult for the student to attempt on their own;
- They can often end up looking messy once completed - after the student has made corrections. This was a point raised by students who struggled with spelling and often had to return to the worksheet to correct their mistakes.

Out of the students present, four stated that although they did enjoy using the computers they found it difficult to keep up with the rest of the group either because they found computer programs confusing with too many options or because they struggled to read the tasks and activities quickly enough. This was based on their use of web sites and educational computer games they had used while at school.

When discussing how such a system would look and how students would like to interact with the system, many suggestions and opinions were raised and on very few occasions was there a majority in agreement. All students agree that the system should be based around the theme of
rugby as they were in at a rugby stadium. One student said that she liked the way Yahoo Mail\(^9\) website allowed her to choose her own colour scheme for the site, based on several pre-designed styles.

### 4.2.5: Discussion

**About problems with the current paper based worksheet approach.**

As discussed above, students often found paper-based worksheets boring to look at which often lead to a lack of interest in completing the worksheet. Also, worksheets were generally very well structured which meant students were unable to adapt the task to meet their individual learning needs and interests but it also meant that many students either found the tasks too simple or too complicated, based on previous experience and ability.

**About specific user needs of the disadvantaged children at the centre.**

Several students at the centre found previous tasks too complicated. In a discussion, it became apparent that this was often caused by lengthy task descriptions, which the student was either, not motivated to, or unable to read, which lead to mistakes being made. Many students also struggle with spelling and grammar and had to first complete worksheets in pencil to allow for the errors they were likely to make. When using computer based systems, disadvantaged children said they were often confused when given several options at the same time which resulted in them losing concentration on the task. As identified during chapter 2, it will be important that the system developed minimises this problem by limiting the options available.

**About the systems visual and physical design requirements.**

As expected, it was hard for students to agree on any particular design, this is often down to individual preference (Nielsen, 1996). However, students did agree that the general structure of the site should follow the **standard design** that is implemented with many sites available on the Internet: navigational options down the side of the screen; titles at the top of the screen; main content in the centre and to the right of the screen. This decision is possibly influenced by web sites that the students have experience with and used in the past, effecting what students think **should** be done and what they **perceive to be correct** (Nielsen, 1996).

**About features and tools students would like the system to include and why.**

The results show that the students want such a system to be interactive but also adaptable to their individual needs allowing them to focus on areas that they need to or that interest them as opposed to following a set course of tasks. Students who struggled with their English said

\(^9\) Yahoo E-mail - www.yahoo.co.uk/mail
they would like the system to help them with this, namely spelling and grammar. These students also wanted the system to help them produce clean, smart work.

4.3 Staff Semi Structured Interviews

4.3.1: Objectives

1. To establish the requirements of the staff at the centre for the system.
2. To identify any limitations on the system.
3. To identify the educational content that should be included.
4. To identify any ‘business rules’ the system must meet.

4.3.2: Participants

The centre manager Mr John Bedford and the centre assistant Mr Paul Dailey were interviewed. They have both been with the centre since its’ formation, hence they have a good understanding of what the system needs to do and the environment in which it is going to be used in. Both Mr Bedford and Mr Dailey have a limited experience with computer based learning and therefore their ideas will not be limited to what they believe is possible. Other potential participants are the student mentors that volunteer to help the children during the sessions. However, generally these mentors have not been with the centre very long and so have a restricted knowledge of the centre and so will not be interviewed during this project.

4.3.3: Procedures and Materials

A semi-structured interview, split into five key areas was prepared based on the recommendation in Robson (1993). First, there was an introduction stage where the procedure and problem was explained followed by a warm-up session during which some general, short questions were asked. This was followed by the main interview stage where the more detailed questions were asked, the interview was adapted based on what the user had to say and wanted to discuss further. The interview then came to an end with a debriefing period where the findings were summarised and a closing session where any final points could be made. By using a semi-structured approach, the interviewer was able to adapt to the specific user allowing as much relevant information to be gathered as possible. During the interview, notes were made to summaries the points raised. These have been included in Appendix C.

4.3.4: Results

Both staff members discussed how the system could offer students interactive worksheets allowing them to interact through the use of multimedia. This may keep the student focussed on the task in hand for longer. Both mentioned the importance that the system was not purely an alternative to the paper worksheets but also offered enhanced, interactive features.
The Design and Development of Educational Software for Disadvantaged Children.

The interviews highlighted that the system should cover a few key areas that are currently covered during the course which are English, maths and health, all with a sporting theme. It is not expected for the system to cover the entire course as many tasks are group based or are more complicated than standard worksheet and so do not lead themselves towards computer based activities. It was suggested that these computer based tasks should be based around quizzes, games, listen and type questions and puzzles as they appeal more than the standard written questions. There are, however, two maths tests - one at the start and one at the end - that could be included and used as a measure of progress in the area of maths.

Both staff members identified the importance that the system offered students feedback on their progress not only with specific tasks but also through the course in general. It was also mentioned during one interview that certificates were a good way to reward students for good progress. It was also highlighted that progress is relative to a specific student as some students are not able to work as fast as others and so will be unable to complete as many tasks. Paul Daley raised the point that there are several tasks during the course, which would benefit from being done in pairs, maybe competing against each other and so some form of collaborative working could be included. John Bedford also discussed how the system should be adaptable for each user hence catering for each student and their individual ability ensuring that tasks are not too easy or too complicated, allowing for them to cover a suitable range of topics. The system should complement the other activities within the centre and should help towards the formation of the students work portfolio.

Both interviews discussed how they need the system to track progress of individual students, each group and age groups so that this information could be reported back to schools, sponsors and for course development. Staff also wanted to be able to update, alter and manage content of sessions based on age group allowing them to personalise each session.

Finally, the interviews raised the point that technically, the system should work with the current IT suite and should not require any additional financing. The only other problem that was identified is students at the club will have very different IT abilities and may struggle to get as much work completed as other students. This raised the point that worksheets should be compulsory, basic for all users or additional, for the users that have more time.

4.3.5: Discussion

About the system requirements for staff at the centre.

The interviews highlighted that as well as the students requirements, the staff also have some functions they require the system to do to aid their work at the club. These include the ability
to monitor progress of individual students, groups and sessions, the ability to maintain lists of users and the weekly sessions including the worksheets within the system. Progress monitoring will allow staff to focus their efforts with students who appear to be struggling. The progress results will also be used by the staff to report back to senior management and sponsors on how successful the club is.

*About any limitations on the system.*

The system is to be used by students and staff at the centre and so must work with the current IT systems already in place. The other major limitation raised by the staff is that the students may have difficulties using IT and have little prior experience or knowledge. Hence, the system should be fairly intuitive and should not require much IT knowledge.

*About the educational content that should be included.*

Several areas of the course are more open to computer activities more than others and so there is a limit to the areas that can be included. The main areas that can be easy to compute but would also offer enhanced learning opportunities to the students are maths, English and health.

*About any ‘business rules’ the system must meet*

The centre offers different sessions for different schools, and the system must distinguish between the sessions and the users in each group. New users are added every ten weeks with old users, and their work being removed.

### 4.4 Document Review

During the staff interviews, John Bedford provided copies of all the current worksheets, lesson plans and tests that were used during the courses. After reviewing these, several groups of worksheets and activities have been identified, as well as multiple-choice questions, short answer questions, tests, group activities and computer-based activities (e.g. games). Also, based on the lesson plans, worksheets were to be completed during certain weeks only as pre-planned by the staff at the centre.

### 4.5 Design Requirements

The staff interviews, student focus groups and sample worksheets, course plans and documentation provided, were used to gather appropriate design requirements, as follows.

#### 4.5.1: Essential Functional Requirements

- Marks for activities should be recorded.
• Student Progress should be monitored.
• Feedback should be provided back to the user indicating if the activity was completed correctly or incorrectly.
• Interactive activities for maths, English and healthy living should be provided.
• Adaptive activities should be included to cater for individual learning requirements allowing students to focus on the topics that they need extra support with.
• User management, allowing staff to add, remove and update user details.

4.5.2: Desirable Functional Requirements
• Tasks that can be completed between two or more people.
• Adaptable content and design based on the users’ preference.
• A tool to allow staff to create their own interactive worksheets.
• The facility to print certificates based on students’ progress.
• The ability to print out completed activities.
• Staff should be informed of students that are struggling with work (little progress).

4.5.3: Non Functional Requirements
• The system should be easy to use and navigate.
• Users should not be faced with too many options at once.
• Activities should be intuitive and require very few written instructions.

4.5.5: System Business Rules
• All users of the system will need to login to the system when they want to use it.
• Staff can access all students’ work and progress details.
• Students cannot directly access other students’ work or progress details.
• Staff will update the structure or each ten-week course before the start of the course.
• Staff will add new students to the system before the start of their course
• Staff will remove old students and work from the system on completion of the course.

4.6 Summary
In this chapter, user needs and requirements were identified through focus groups and semi-structured interviews. These requirements have been summarised into functional and non-functional. Through the use of more focus groups, a prototype for Ronny’s Den will be produced. Future focus groups should be conducted in smaller groups of eight as opposed to one large group of sixteen to give the moderator more control over the pace of the session. Based on the identified requirements, the design for Ronny’s Den will now be considered.
Chapter 5: System Design

Phillips (1997) emphasises the importance of system design within system development, this is acknowledged through the chosen methodology (see Chapter 3). During this chapter the system design will be completed based on the requirements identified in Chapter 4. The design forms part of the minimum requirements for this project, as discussed in Chapter 1.

As discussed by Rees (2001), there are four key areas of the system design. In relation to this project these four areas are:

- **System Content**: The educational and administrative content and functions that need to be in the system.
- **Navigational Structure**: The logical structure of the system, how the functions are connected together and integrate.
- **Visual Design**: The physical structure of the page and the site, including visual design.
- **Technical Design**: The structure of the supporting databases.

The first two areas, system content and navigational structure, form the conceptual design. Preece et al. (2002) defines the conceptual design as a *description of ideas and concepts about what the system should do*. To achieve this, it is necessary to isolate the tasks users will be performing. These will be used to identify the structure and technical design required.

To aid with this process, the **Unified Modelling Language** (UML) will be used to provide a level of abstraction, allowing the individual functions to be identified (Bennett, 1999).

- **UML Use case diagrams** will be used to provide a high level view, summarising interactions between system users and system functionality.
- **UML Activity diagrams** will be used to aid the navigational design and to describe the flow of activity through the system.

Visual design will consider HCI issues and how they may affect users of this system. It is important to ensure that the visual design caters for this specific user group and helps to motivate them into using the system (see Chapter 2).

Finally, the technical design for the system will be addressed. This will include ER diagrams and table structures for the required databases required.
5.1 System Content

In Chapter 4, the main content areas that need to be included in this system were identified. A UML case diagram is available in Appendix E. These can be summarised as:

- Educational content.
- Useful information/extras.
- Administrative content.
- Progress reporting content.

5.1.1: Educational Content

Educational content to be included in the system is already available through worksheets and lesson plans used at the Rugby Club. The design is limited to the way in which information is accessed and used and not the creation of the information itself.

As discussed by Preece et al (2002) and Phillips (1997), the design of educational content for learning systems often takes the form of either a flow chart or a storyboard. A flow chart briefly outlines in writing what can be found on each page and describes the natural flow through the system. The alternative method is the use of a storyboard to give a lot more detail on the layout and content of each page of the system. The design of this system, as discussed previously, will use UML activity diagrams to identify the flow through the system.

Based on findings in Chapter 4, tasks can be grouped into six categories with each worksheet embedding an area of the taught curriculum. The groupings for task are: games; multiple choice questions; short answer questions; tests; group activities; research and present.

The first four groupings were identified during the requirements gathering stage as being ideal for a computer format. The last two categories of activity would be harder to embed into a computer system as they are directly aimed at improving communication; problem solving and team working skills and are also not assessed in the same way as the other tasks i.e. there is no correct answer. This system will include activities covering the first four categories: games; multiple choice questions; short answer questions and tests.

5.1.1.1: Worksheets

To accommodate the multiple choice and short answer questions, worksheet style activities will be included. These will follow the style and format of the current paper based worksheets, but will include more graphics and colour as requested during the focus groups (see chapter 4). Once complete, the system will contain dozens of worksheets and it is not within the scope of this project to design them all at this stage. Instead, using the storyboard
approach recommended by Phillips (1997), sketches for a sample of worksheets, based around the “health” area of the course have been included in Appendix E.

Once complete, the full system will have worksheets on the following taught areas:

- **Maths**: multiplication; fractions; time; measurements; currency.
- **English**: spelling; verbs; nouns; grammar.
- **Health**: healthy eating; fitness; drug awareness; dangerous areas; street safety.

All worksheets should follow a common visual structure (Rees, 2001) however the content and assessment method for each task varies based on the activity. To cater for this, a web based scripting language combined with a database will be used (see Chapter 6, Technical Implementation) to store worksheet questions and answers, generating worksheets as requested by users. As well as helping students produce neat work, which can be corrected before printing, it also removes the need for worksheets to be individually created.

Worksheets will have the same basic structure including a worksheet title, a brief introduction or explanation to the task and the task(s) itself. A worksheet can comprise of multiple choice and short answer questions. These style questions are good for the Rugby Club users as they require very little mouse and keyboard use compared to interactive games which will allow the less able computer users more chance to keep up with the others if they want to. Short answer questions are also preferred as they keep the student focused on the question for enough time to answer it whereas, more structured, long answer questions may loose the students interest quickly.

All worksheet questions must inform the student when they have entered an incorrect answer and should provide them with useful feedback, allowing them to see why they were incorrect. At the end of the worksheet an overall mark should be displayed so that the student can see how well they have done.

**5.1.1.2: Tests**

Another form of activity the system must offer is that of short tests. All students take a maths test at the start and end of the course so their overall progress can be assessed. By adding the tests to the system, staff can get feedback on results as soon as the tests are complete. The system will also identify, by highlighting questions that scored low marks consistently, which areas the students need to recap during debriefing sessions.

Tests will be of similar design to worksheets but will be based solely around a series of short
multiple-choice questions. If a student gets a question wrong on the test, it is not necessary for the system to provide feedback as the test paper is always discussed as a group after the test. The other difference compared with worksheets is each test question includes a diagram or picture to aid the student with the problem.

5.1.1.3: Games
Games were identified to be a favourite activity of the students (see Chapter 4) although staff are keen to keep the number of featured games to a minimum so not to distract the students from the other activities. To ensure the games provide the students with the correct level of support in the appropriate areas, they will need to be custom made. The games can come in many forms, for example word searches, mazes and memory games. Due to the interactive nature of games, they are ideal for use with multimedia authoring tools such as Macromedia Flash. This will allow games to be fully interactive, involving the user.

It is beyond the scope of this project to develop the required games as it can be a complex and time consuming process. This is something that could be extended at a later time.

5.1.2: Useful Information
As well as activities directly related to the study of curriculum areas, users were keen to have a section for sharing useful and popular websites with each other. This section would allow both staff and students to suggest websites, giving a brief description and a web-link. Users can access this area, searching for links based on categories: education; music; news; entertainment; sport; hobbies; food; other.

As an enhanced feature, the system should suggest to the user, based on the users “personal information” (which they enter when they first use the system) websites they may find interesting. This should appear on the welcome page to the system every time the user logs on. This can be achieved using database queries to compare the descriptions of websites against the users list of hobbies.

5.1.3: Administrative Content
If members of staff login to the system, they will be given the below options as links. Each link will take them to a set of further options relevant to that area (see Appendix E for UML). There are three main areas of administration within the site:

- User maintenance.
- Worksheet maintenance.
- Session maintenance.
**User maintenance** will allow the staff member to view all current users details (name, school, key stage), clicking on their name to see their full details (hobbies, weak subject, favourite subject, home address). Staff members will also have the option to delete users - for a current session, a group or individual user. Finally, staff will have the option to add new users, ready for forthcoming sessions.

**Worksheet maintenance** is the area staff will use to view a list of all current worksheet and test titles with a link to all questions within that worksheet. Staff will then be able to update or delete any of these questions. From this area within the system, staff will also be able to add new worksheets, questions and answers and also delete entire worksheets if they are no longer required. Staff will not be able to create new games as these need to be done with external software however, if a game has been designed, staff will be able to create a worksheet which links to this game, allowing students to access it through the usual manner as with standard worksheets.

Finally, **session maintenance** is the area of the system where staff can add and maintain each weekly session for the various key stage groups. Staff members can add a weekly session and assign, to that session lists of worksheets and activities, stating weather the worksheet is compulsory or an optional extra for the faster students. Each session will have a date and a key stage attached to it. Once again, staff will be able to delete entire sessions or update them individually as required.

### 5.1.4: Progress Reporting Content

There will be two ‘progress reporting’ areas to the system. **Staff progress** reporting will give staff a tabular summary of the average mark per group and key stage. Staff will select a group that will then show a summary for each individual student within that group. Clicking on a student will bring up that individuals breakdown for all marks achieved so far. It is also necessary that students who are struggling with the work be identified to the staff. The system will show a list of students, on the staffs’ progress page, that have achieved a low average mark. Staff can then look at the individual marks for these students in greater detail.

The **student progress** reporting is less complex as it should only show the student their personal marks. At the top of the page, a summary of their marks will be visible and underneath a full breakdown of marks achieved for each task will be listed.

### 5.2 Navigational Structure

The navigational structure of the system provides the user with the means to progress through
the various functional areas. However, as discussed in Chapter 4, the system should cater for an individual's learning need and so it is important that navigation through material within the system is flexible, allowing users to develop their own routes. This approach will allow students to facilitate their own learning and focus on the areas they feel necessary (see Chapter 2). There are a number of navigational structures available for interactive systems that could be used; these include linear, hierarchical and unstructured (Phillips, 1997).

A **linear** structure restricts the user by enforcing a pre-define route through the system thus reducing the effectiveness of the learning environment (Rees 2001). The advantage of linear is it allows the staff to control exactly the order in which students complete exercises and will ensure students don’t wonder off onto other tasks they should not be completing at the time.

An alternative approach is that of **unstructured** navigation. This is where the navigation is fully open allowing the user to move between any pages within the system. This raises issues as it will allow the user to get easily distracted but could also cause the user to get lost in the system (Rees, 2001).

The final navigational system is that of a **hierarchical** structure. This is a semi-structured approach limiting users to certain aspects of the system but allowing them to fully browse other areas. For example, a user can only move between sections of a worksheet in the correct order but they are able to browse through the available tasks in any order.

The navigational structure to be adopted by this system is based on the hierarchical approach but will also include **business rules**, for example:

"**Worksheet one should only be completed during session one**"

As shown in figure 5.2, applying these rules to the system and database, allows access to certain areas of the site to be restricted until the appropriate time, which is decided by the staff at the time, they design the course structure and lesson plans. This system navigational structure is summarised in the appendix (Appendix E).

To aid navigation through the site, a common **navigation bar** will be included (see figure 5.4). This navigation bar will be available on all areas and pages within the site and will contain the same options. This will allow users to navigate between the different activities and functions available to them independently of their location within the system. If a staff member is logged in, they will also see the administration options.
As discussed previously, it is important that students can only access worksheets related to the particular week and key stage they are in. The navigation bar will list all worksheets available to the student at that particular point in time, allowing them to access them as they require and reducing the need for the user to search the site for the tasks they should be doing.

5.3 Visual Design

The Physical design of a system involves considering the detailed issues of interface design including screen layout, text and colour (Preece et al., 2002). Phillips (1997) states the great importance of interface design to providing effective, interactive educational based computer systems as it aids the communication between system content and user. The first factor to cover is that of screen layout. To create an intuitive learning environment for the students, all pages should follow a common design template (Rees, 2001), which will also make the design of future worksheets a simple task. As shown in figure 5.4, the screen will be broken into three key areas; navigation; title and content.

Each page should present to the user, the educational content they require in an aesthetically pleasing manner that enhances the user’s interaction with the system (Nielsen, 1993). Screen
sketches are available in Appendix E. As it is the educational content that is of key importance in this system, it is important to ensure this is where the user focuses their attention, and that they are not distracted by further elements on the page. Phillips (1997) cites that the human eye is drawn to the largest element on the screen and it is here where the user will focus. As shown in figure 5.4, the main element of the page is that of the educational content with the navigational and title elements being less dominant.

Figure 5.4: Screen sketch showing the basic structure to all pages within the system.

Colour can aid the way in which a student interacts with a system by emphasising key elements but can also provide the user with a consistent feel to the system making navigation and general system use easier (Travis, 1991). It is important to note that in this system, colour is used only for its aesthetic quality. The idea of customisable colour schemes was raised in requirements gathering (Chapter 4), however, this feature will not be included in Ronny's Den due to time constraints. As recommended by Nielsen (1993), the Ronny's Den colour scheme will be limited to two main colours, based on the Leeds Rhinos Rugby Club theme (dark blue and orange) this ensures the system is not visually distracting (Preece et al., 2002).

Shneiderman (1998) cites that reading from a computer screen is more difficult than reading from printed material and therefore, text is also an important consideration for this systems’ design. During the requirements gathering stage (see Chapter 4), it was highlighted that students often struggle with tasks if they are provided with too much text to read initially. The amount of text used in this system will be kept to a minimum, with brief task introductions where possible.

This system will use a negative contrast with text to increase the readability. As cited by Dix (1998), a negative contrast in a display is one where dark characters are displayed on a light background; it has been found to be easier to read and preferred instead of a positive contrast.
Rees (2001) states that the use of graphics, sound and other multimedia can also aid the use of such a system. Appropriately placed images, for example, can keep the attention of the student on the main educational content but will also lead as an ‘unofficial’ path through the system as students will click from image to image, often treating them like buttons.

5.4 Technical Design

The key technical consideration is that of database design and the most efficient way to store data including user data, session information, and worksheet questions. It is recognised that due to the scale of information that should be recorded, and to cater for automatic generation of worksheets, a database system will best suite. This has been discussed further in Chapter 6, technical implementation. Here, the structure for the chosen database will be discussed although full ER diagrams and table structures are available in Appendix F. There are three key functions the database will be supporting. These are:

- User data, including marks and progress.
- Session information, including each session based on date and key stage and the tasks that should be completed during that session.
- Worksheet information, including the questions that make up a worksheet, the answers and links to any external material (e.g. multimedia games).

A relational database will be used and tables should be created within this database for the above three areas however it is important that the database is normalised to 3BCNF (Korth et al. 1997). Relational database offer many benefits over flat-file systems; accessing data from a large flat-file will take a significant amount of time and slow the system down. Searching for records in a flat file is also difficult as it is necessary to check each entry individually, which will also slow the system down.

First, objects within the system were identified, which then formed the core database structure. Tables were designed for the following objects: User (Staff/Student), session, worksheet, multiple-choice question, test question, multimedia activity (e.g. flash game), web link and student mark. The full design of the database and the relationships between the objects is presented in the Entity Relation Diagram (ER) in Appendix F.
Chapter 6: Technical Implementation

Here, the technical details of implementation are discussed, outlining the decisions made as regards to the development environment for the system. As discussed during the system design, (Chapter 5) - this system will be developed using web technologies for use with Internet browsers namely Microsoft Internet Explorer as this is what is used at the centre. For a web-based system, there are three main components that need to be considered:

- A scripting language to create the interactive aspects of the system and to produce dynamic content.
- A database to store user data, work and worksheet information.
- A web server, which will store the system and associated files.

There is a wide range of solutions available for the above points however for the purpose of this project the choice was limited to the following:

- Hyper Text Mark-up Language (HTML) combined with either ASP or PHP for the scripting language.
- MySQL and Microsoft SQL Server for the databases.
- Apache and Microsoft Internet Information Server (IIS) for the web server.

6.1 Scripting Language

As the system is being developed for use with Internet browsers, HTML, a language commonly used for defining the layout and structure of web pages will be used. HTML uses tags to describe the layout of a page and is quick and easy to develop compared to programming language such as Java. Development can be made even easier by using a HTML editor such as Macromedia Dreamweaver that allows the developer to create a system using a ‘drag and drop’ style approach allowing web based systems to be developed quickly with little advanced knowledge of the language required.

Although HTML can be used to create the core structure, it is not sufficient for the more advanced, dynamic and adaptable aspects of the system as it can produces static pages. For dynamic content to be included, a scripting language is required which can be embedded into HTML code. When choosing a scripting language, it is important to consider integration with the chosen database and system and any prior knowledge the developer has of the language.

This system will be developed using PHP scripting language, which is a server side script. It is an open source product that can be used on both Windows and UNIX based servers giving
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the system flexibility for future development. PHP also includes many built in functions that can be used to access databases, display results and process data. The developer of the system is familiar with PHP allowing development to proceed instantly. PHP scripts will be used to offer the extra-required functionality including the following modules:

- User authentication.
- Answer processing, marking, and certificates.
- Worksheet generation.
- Progress monitoring and reporting.
- Session and weekly task management.

6.2 Database

As discussed during the requirements gathering section (see Chapter 4), the system must record the progress of students and their marks for individual tasks. The system is also to maintain details of worksheet and a timetable of tasks to be completed by each group. As this data will be different for each group, and is likely to change each session, a database will be required. When considering the best database system to use it is important that it is compatible with the current systems and the chosen scripting language, PHP. There are two main alternatives to consider and these are MySQL, and Microsoft SQL server.

MySQL is open source, available free of charge under the GNU licence\(^\text{10}\) and is supported by PHP through its’ extensive range of built in features\(^\text{11}\). Database queries are performed using a version of SQL which is very similar to that used within the school of computing and is also familiar to the developer. Queries are used with PHP pages to insert and maintain data.

Microsoft SQL Server is widely used throughout business however does attract a license fee. SQL is also used as the query language and is also supported by PHP, although not as thoroughly as MySQL. SQL Server offers a greater range of database functions such as the ability create procedures, allowing frequent tasks to be defined as functions that can then be accessed by other programs and can reduces the transaction time.

MySQL has been chosen as the database for this system as it is free to use, is easily accessed by PHP and has recently been shown to provide better performance and scalability compared with SQL server in terms of web applications\(^\text{12}\).

\(^\text{10}\) GNU Software Licence: http://gate.ac.uk/gate/licence.html

\(^\text{11}\) PHP Documentation covering MySQL features: http://www.php.net/docs.php

\(^\text{12}\) MySQL vs. SQL Server 2000: http://www.databasejournal.com/features/mssql/article.php/3087841
6.3 Web Server

The web server is an application used to store the system files, process server side scripts and process requests made by the client to access the system, its’ HTML, PHP and database. There are two main choices that need to be made with regards to web servers; they are the chosen server to use and the location for it to be installed.

Web servers can be installed either locally, to form an intranet style system available exclusively to machines within the internal network or on an externally available Internet server allowing, in theory, access to machines throughout the world. If the web server, and hence the system, is installed on a globally accessible server, security will be put in place through the use of PHP scripting to ensure access is limited to authorised users of the system. The chosen web server must also be able to parse the scripting language chosen, in this case PHP. For the purposes of this project, web server available on the Internet will be used which will allow access to the prototype from locations other than the Rugby Club. As the system will be developed in an environment supported by both Windows and UNIX servers, it can be moved internally at a later date if required.

The options for web server are Microsoft IIS and Apache. Apache has been chosen as it is an open source and free to use under the GNU licensing agreement, fully supports both PHP and MySQL and can be used with either UNIX or Windows based servers13.

6.4 Summary

In this chapter, the development environment for the project has been decided. Open source products will be used including HTML and PHP for scripting, MySQL for the database and Apache for the web server. These choices attract no license fees or installation costs, can be used with both UNIX and Windows applications and servers and are already within the developers technical ability and so will not require further time to learn any syntax and installation procedures.

13 Apache Website documenting the feature and OS it supports: http://www.apache.org/
Chapter 7: Iterative Design and Prototyping

A prototype for Ronny’s Den was developed so that user testing and evaluation could take place. The prototype developed is available at www.burtie.co.uk/lrcss/fyp/ although the complete system would have its own domain name (e.g. www.ronnysden.co.uk). During this chapter the functionality included in the prototype and the problems encountered during the development will be discussed. The two forms of evaluation used are heuristic and user evaluation; these will also be discussed.

As raised by Finlay et al. (2004), requirements for an interactive system cannot be fully identified at the start of a project due to the nature of these systems. Finlay et al. (2004) cite that to be sure the identified user needs and requirements are correct and complete, a system should be built and tested with real users, highlighting any incomplete requirements. Finlay et al. (2004) refer to this process as **interactive design**, and describes it as incrementally improving a system through the use of prototypes to “simulate or animate some, but not all of the features of the intended system”.

Finlay et al. (2004) identifies four main forms of prototyping which could be used with Ronny’s Den, these are:

- **Storyboarding**: A graphical representation to depict the appearance and structure.
- **Throw-away**: A prototype is built and tested but not used. Knowledge gained during the development is used to produce the next prototype.
- **Incremental**: The final system is decomposed into functional components which are then built and tested separately, combined together incrementally.
- **Evolutionary**: The original prototype forms the basis of each subsequent prototype by extending the functionality further iteratively.

The major issue that prototyping can raise is the effect it may have on the non-functional aspects of the system. For example, often, the most important aspects of a system are those that are non-functional such as reliability (Finlay et al., 2004); if a system development is rushed, as may be the case through prototyping, these non-functional requirements may be missed. These are issues that should be identified and checked during system testing.

7.1 Ronny’s Den Iterative Design

Ronny’s Den will use evolutionary prototyping and storyboarding during the iterative design stage. This will allow a basic prototype to be developed into a functional system that meets more of the user needs and requirements. By including the users through iterative design and
prototyping, requirements originally identified in Chapter 4 can be confirmed and refined. To aid the iterative design, focus groups were also used; however, only two iterations of the design were possible due to time limitations. The development stages that Ronny’s Den has gone through during this project are:

1. **Storyboarding** during initial focus group with users (section 7.1.1).
2. **Functional prototype** and second focus group (section 7.1.2).
3. **Evolved prototype**, based on the results of stage two (section 7.1.3).
4. **User testing** to identify flaws and faults with Ronny’s Den (section 7.4).
5. **Heuristic testing** to identify flaws with the system interface (section 7.5).
6. **Final prototype** based on results of stages three and four (section 7.6).

### 7.1.1: First Iteration - Storyboard Prototyping

Storyboarding was used initially to gain confirmation that the requirements and user needs had been correctly understood. The storyboards used were those developed during the design stage of Ronny’s Den (see Appendix E). As recommend by Nielsen (1997), the focus groups were limited to eight users allowing the moderator full control of the session unlike previous focus groups (see Chapter 4).

Students were presented with the storyboards in the order they may use the system i.e. login screen, welcome screen, worksheet, progress report etc. Students were asked to comment on the storyboards; notes made by the moderator during these sessions are available in Appendix G. This stage did not raise any major issues and students agreed that the system looked good. Now the design had been confirmed, a functional prototype could be developed.

### 7.1.2: Second Iteration: Functional Prototype

Based on the design stage (see Chapter 5) a functional prototype was produced. Due to time limitations, only basic functions were included in this original prototype: a healthy eating worksheet, an English verbs worksheet and a sample maths test.

Two groups of eight students were used for the focus group, during which the prototype was presented and discussed. The prototype was presented to the group by the moderator using a multimedia projector. User testing was not included at this stage due to time limitations however the primary purpose of this iteration was to discuss the issues and concerns about the user interface for the system, noting users’ reactions and ideas. Notes made during this focus group session are available in Appendix G. During the discussions, students commented that looked colourful and interesting to use but would like to see more images and pictures. After receiving users’ approval and comments, a more functional prototype will be developed.
7.1.3: Third Iteration: Evolved Prototype

The third iteration was the major prototyping stage for Ronny's Den. At this stage, a fully functional prototype was produced and was used during user and heuristic evaluation. Section 7.2 discusses the functionality that was presented in the prototype. Sections 7.4 and 7.5 discuss the evaluation stages and section 7.6 discusses the final alterations made to the prototype during this project based on the evaluations.

7.2 Ronny’s Den Prototype Functionality

Due to time limitations it was not possible to include all features. A selection of features was chosen to ensure the prototype covered the essential requirements but was also sufficient for user and heuristic evaluations. The prototype is focused around the student although some basic admin features have also been included. The key features presented are:

- User Login.
- Weekly task list (based on the current session week and the users’ key stage group).
- A multiple choice based worksheet.
- A short answer question based worksheet.
- A sample maths test.
- Student mark recording.
- Student progress reporting.
- Useful web site links (including the ability to add and view links).
- The ability for staff to add new worksheets and questions to the system.
- The ability to add and remove users to the system.

7.2.1 User Login

When the prototype is first accessed, a user login screen is displayed asking for username and password. The user enters their username and password into the form provided, these values are then compared to those stored in the database. If correct the user is presented with the Ronny’s Den welcome screen, otherwise they are told login was unsuccessful.

7.2.2 Session and Worksheet Management

During section 5.2, it was stated that business rules should be used to ensure students only have access to the worksheets that are due for completion in that particular week. To cater for this, the database included the following tables:

- **Session** – to record the date, title and group of a particular session
- **Worksheet** – to record the title, and core details of the worksheet
- **Session_Worksheet** – to record the worksheets to be completed during a session.
PHP pages were used to check the current date with those stored in the database to retrieve the details for each session; this was then used to select, from the database, all associated worksheets. Although this function works, for the purpose of the prototype, the week number was hard coded to week 2; worksheets for each week would have otherwise been required.

7.2.3 Worksheets and Tests
As it is the functionality that is being evaluated and not the educational content, only a small sample of worksheets and tests were created. Both are dynamically created from the content of the database that means individually HTML pages for each worksheet are not required.

Worksheets and test both followed the screen layout discussed in Chapter 5 which meant they were consistent with the rest of the site. Two short answer question based worksheets, a multiple choice and a maths test were included in the system. Students could select the worksheet title from the navigation bar on the left, opening the particular set of question in the main content area. On completion, students clicked the “submit” button, which would record their total mark in the database.

7.2.4 Student Marks and Progress
On completion of any task, a PHP script is initiated which first, compares students’ answers to the correct answers stored in the database for that particular worksheet, and then records the final mark for the worksheet as a percentage in the students’ record. Multiple choice questions were simply checked against the correct answer; short answer questions were compared to an ideal answer stored within the database using the RANK function in MySQL. Students are not able to take the same task twice and obtain a mark; a function has been included to check if a worksheet has been completed, if so, no mark would is recorded.

The student progress report has been designed as in Chapter 5. It uses a PHP page which calls all student marks, and completed worksheet data from the database for the student that is logged in. It presents this information the user in a tabular format (see Appendix H).

7.2.5 Useful Information
The ‘useful information’ produces a list of URLs previously entered by users; this list is then grouped by category type. Users can click on a link to open the site in a new browser window. This area also offers the user the ability to add web sites they recommend. At the bottom of the page is a small form for the user to enter their recommendations. It is envisaged that by including the users name with recommendations, they will get a sense importance; this was highlighted as a beneficially factor during Chapter 2.
7.2.6 Staff Administration

Staff administration is only visible to users who are members of staff; a PHP page that checks the username of the logged in user to the database to see which user type they are.

In the prototype, staff are only able to delete one student at a time; they are presented with a list of all current users with the option to delete a user next to each name. The full system should allow users to delete entire groups of users at the same time to decrease the time required to maintain the system. Also, admin users are currently limited to adding new worksheets although the ability to maintain and delete current worksheet would not be complicated to add in a future iteration.

7.3 Problems Encountered

The main problem that was encountered during the prototyping was with organising user focus groups. It was important that focus groups were held at times suitable with the centre staff and users as not to disrupt their work. This meant there was limited control over the schedule for prototyping, which resulted in some areas of the prototype being rushed to ensure they were completed on time. To acknowledge this problem, it is important that the prototype is fully tested to ensure any errors that are present are identified so they can be corrected.

Another area that caused problems was the graph that should have appeared to student progress page. Although the graphs were implemented successfully on the developers PC, once transferred to the web server for testing they were no longer functioning. This was due to an old installation of JP Graph, the libraries used to generate the graphs; unfortunately this could not be resolved before prototype testing and so has been excluded from this iteration.

Minor problems were encountered when moving the prototype from the developers’ machine to the web server however these were resolved by upgrading the installations of PHP and MySQL on the web server to the latest versions (see Chapter 6).

7.4 User Evaluation of System

The objective of user testing with Ronny’s Den was to identify any problems with the design and missing functionality. It was important to ensure that user requirements had been appropriately met, hence the user involvement at this stage.

7.4.1: Procedures and Materials

A user testing session was arranged with the Rugby Club to include two groups of eight students, as had been used throughout prototyping so far. Each session was due to last forty
minutes followed by a twenty-minute discussion, in the same style as previous focus groups. Unfortunately, only one group of eight students were available for the user testing session although this did mean more time could be spent with these users to discuss the system.

The session was held in the centres ICT suite, using Microsoft Internet Explorer. Students were briefed on how to login to the system and were asked to complete the sample worksheets, following any instructions given on screen. This approach was adopted as it best matched the way users would normally use the system once implemented. Notes on the testing are available in Appendix G however key points are summarised in section 7.4.3.

7.4.2: Participants
The eight students involved in testing had contributed to the previous focus groups and so were familiar with Ronny's Den. As well as the eight students and developer, who closely monitored the session, two student mentors were also present who were there to assist the students with any errors they had with the system. Student mentors were asked to keep a record of any problems they encountered during the session.

7.4.3: Results Discussion
The general view amongst the students was that although the prototype offered only limited functionality, the full implementation of Ronny's Den would be extremely useful to support their study as the centre. All eight students successfully used the system without any trouble; all were able to sample at least one worksheet, a section of the maths test, progress reporting screen and useful web links page. It was noted by both the student mentors and the developer that several of the students repeatedly tried clicking the pictures down the right side of the screen, originally used to make the welcome page more visual appealing. This implied users thought the pictures were operational buttons and should have taken them somewhere; this is something that should be confirmed during heuristic evaluation.

Although students understood the prototype was incomplete, they still commented on the lack of multimedia games, which implies this feature could be of greater importance to the user than first identified and should therefore feature highly on additions that need to be made.

The first worksheet was familiar to students as they had completed it in paper format during a previous session at the centre. Students were asked how the system compared to the paper based worksheet. All students said they preferred doing the worksheet on the computer as it was more interesting, even though the questions were exactly the same; this could be due to the visual appearance of the system. Several students commented on the worksheet being
easier, however this is likely to be because they had already completed the task.
Students suggested that the web links page have an option allowing them to select the desired
category instead of all links being listed on one page as it involved a lot of scrolling.

7.5 Heuristic Evaluation of System

A heuristic evaluation was carried out on Ronny’s Den to verify that comments made by
users, regards the design and interface were reliable. Heuristic evaluation is a systematic
inspection of a user interface design for usability (Nielsen, 1993). The aim is to identify any
usability problems that are present so they can be corrected during an iterative design cycle. A
small group of evaluators, experts in the field of usability, examine the system based on a set
of recognised usability principles (Nielsen, 1993). During heuristic evaluation it is important
to ensure an appropriate set of heuristics are used, ensuring suitable evaluation is undertaken;
this is to accommodate a recent change in new, interactive technologies where some current
heuristics may be inappropriate (Preece, 2002).

7.5.1: Procedures and Materials

Based on Nielsen’s (1993) usability heuristics, and Johnson’s (2000) first principles, heuristic
evaluation criteria were produced (Appendix I). The evaluator was provided with a summary
of the system and a small set of tasks similar to those that would be performed by the user.
This allowed the expert to use Ronny’s Den as a typical user would. The expert spent thirty
minutes using the system and a further thirty minutes discussing the issues that arose.

7.5.2: Participants

An undergraduate student from the University of Leeds, School of Computing department,
undertook the heuristic evaluation. This student had achieved a high mark in the related HCI
module taught at the University covering heuristic evaluations.

7.5.3: Results Discussion

Feedback from the heuristic evaluation is available in Appendix I however a summary of the
key points is included here. The expert states that Ronny’s Den is generally good and has a
usable interface however he does identify several improvements that need to be made.

The evaluation highlighted the fact the main page to the site contained too much text for the
user to read; this would but the student of and could result in them loosing interest before they
had even started. It was also noted that the user might think the images on the side of the
screen were functional buttons and should take them somewhere; they may get frustrated
when nothing happens. The major distraction on the page is the scrolling text at the top; this
would act as a distraction and should either be left static or removed completely. Navigational links were consistent however; this user group may prefer to have image-based navigation as opposed to text which would improve the usability of the site. The expert stated that there was no button to return the user back to the home page; a home page button would give the user confidence in using the system, as they know they can easily return home. The expert also stated that there was no logout button; this should be added to make the user more comfortable about using the system by assuring them they can successfully logout at the end.

The final point noted by the expert was that of consistency; although the majority of the site is consistent, there were a few minor issues. For example tables on the worksheets used borders however tables on the useful web links page had no borders. Increasing the tags included within the style sheet and enforcing the use of this CSS throughout can resolve this.

### 7.6 Final Prototype Changes

User testing and heuristic evaluation highlighted some areas to the Ronny’s Den that needed extra development. It is not within the scope of this project to implement all of these changes however, some of these issues have been considered in the final iteration. A summary of further factors that could be considered in the final version has been included in Chapter 9. Alterations made to the prototyped (discussed in section 7.2), based on heuristic and user evaluations are:

- Scrolling text at the top of each page has been made static to stop distracting users.
- A logout button has been included at the bottom of the navigational bar.
- A button to return to the home page has been included on the navigational bar.
- Graphical icons were used with the text links in navigation bar.
- Welcome text on the home page was minimised.
- A CSS style sheet was introduced but not fully implemented.
- One game (Tower of Hanoi) has been included as a task (based on user desire).

### 7.7 Summary

During this chapter, the stages of iteration for Ronny’s Den have been discussed as have the functionality offered by the final prototype. User testing and heuristic evaluations were undertaken to identify any flaws or missing requirements within the system that needed including in any further design iterations. Some of these changes were made to Ronny’s Den during a final iteration of prototyping in the prototype. Based on user and heuristic testing, Ronny’s Den is a successful system however, to assess the overall success of the project, it is now required that the project be evaluated which will include assessment of the project stages, methodology and minimum requirements.
Chapter 8: Project Evaluation

In Chapter 7, both users and experts evaluated the prototype for Ronny's Den, however, in order to establish whether the project has been a success, it is important to evaluate it against the minimum requirements (see Chapter 1). The second section of this chapter then evaluates the individual stages of the project as discussed during the methodology review in chapter 3. Finally, suggestions for further work that would extend both the project and the Ronny's Den system further are cited.

Even though the main project objective was to design a section of the learning system Ronny's Den, it is not possible to evaluate the design on its educational integrity or improvement to student learning. If however, a full implementation of the design had been achieved then it would have been necessary to devise a method of assessing the system’s educational value. The evaluation of the solution is based on how far the deliverables have been fulfilled.

8.1 Evaluation against Minimum Requirements

Research existing ICT solutions for disadvantaged children

Initially, computer based learning systems (CBLs) were discussed including the use of web based learning systems. It was found that although ICT was common in the educational environment, the use to ICT for disadvantaged children was not utilised. Two CBLs that could be used to aid disadvantaged children were then reviewed (see Chapter 2) which highlighted the benefits such ICT solutions could offer study support.

It was also necessary to research the true meaning of disadvantaged children, highlighting the specific needs that made them ideal candidates for such a system

Review of user centred design technologies to identify how they can be used for designing educational software for disadvantaged children.

A review of system methodologies was undertaken to identify the most appropriate methodology to be used throughout this project. The user interaction model was chosen as the most appropriate methodology as it offers full support for user centred approaches and includes users throughout the development of the system.

Based on an empirical study, to include semi structured interviews and focus groups as appropriate, identify the user needs and produce requirements.

Several focus groups with the students and semi-structured interviews with staff at the centre
were undertaken to identify user needs. From this study a full set of requirements for Ronny's Den were identified (see chapter 4). The focus groups and semi-structured interviews were undertaken with a proportional representative sample of the future users for the system. A review of current documentation, teaching aids and worksheets was also undertaken and has been summarised in chapter 4.

*Design a system for Leeds Rhinos Study Support Centre following appropriate methods.*

Based on user needs and requirements, as identified during chapter 4, a full design for Ronny's Den was produced. This included the visual, interface aspects to the system and also technical aspects, namely suitable scripting languages, databases systems and web servers that the system could be created with.

*Develop a prototype to include the basic functionality of the system.*

In the true nature of user centred design, a prototype was created and re-developed using evolutionary prototyping and iterative design including the use of focus groups. The initial prototype presented basic functionality to include sample worksheets and tests. The final prototype developed during this project offered many of the systems requirements and functionality including administration tools, worksheets, tests and user progress reporting. This prototype is available at www.burtie.co.uk/lrrcss/

*Development of full system to include further subject areas*

Through iteration, the prototype was developed into a usable state. Further functionality has been included, including the ability for extra worksheets and subject areas to be created by the staff at the centre.

*Evaluation of full system*

Evaluations were undertaken on the Ronny's Den prototype. These included user based evaluation and heuristic evaluations undertook by a HCI expert. These identified areas of Ronny's Den that needed extra development and led to suggestions for further work.

**8.2 Evaluation of Project Stages**

Evaluation of the project stages has been done to assess whether each of the stages were appropriate for this system, and identify if they assisted with the development of Ronny's Den. The evaluation will assess whether the background research provided an enhanced understanding of the problem, enabling an appropriate solution to be developed; whether the chosen methodology was suitable for this project; whether user requirements were successfully gathered; whether an appropriate design was produced, meeting all user requirements; and whether the project was developed within budget and schedule.
requirements; whether the prototype produced was sufficient for user and expert evaluation.

The background research consists of background reading and a brief evaluation of existing solutions. However, the system evaluations were very brief as the system identified were not directly designed for this problem definition and so offered little insight although did highlight key areas that should be considered during Ronny’s Den such as use of images and sound, navigational structure and the level of educational content. Background reading was limited to books, journals and web resources, which will effect the quality of the findings. Journals offer a good form of reading as they are well researched and checked before publishing. Although books are also valid sources, they are often old, as is the case with many sources used in this project. More use of journals should have been made.

The chosen methodology, interaction lifecycle model, was suitable for this project. It was followed throughout the system development also allowing for iterative design stages during prototype production. Users were involved during much of the project development from design through to user testing. As well as users contributing towards the final system design, there was also the indirect benefit of students gaining improved motivation and communication skills through taking part in focus groups and group discussions. Students also had a sense of importance as they were being asked their opinions about something; these are all important factors with disadvantaged children as discussed in Chapter 2.

Requirements were gathered based on focus groups, semi-structured interviews and a review of teaching material available at the centre. The semi-structured interview and focus group approach worked well, as it allowed the interview to focus on areas that were raised during the sessions if they appeared important. The focus groups enabled the developer to identify the important requirements and user needs however due to the large size of the initial focus groups, requirements gathering were not straightforward. It is important to acknowledge, focus groups with children, especially disadvantaged children such as this user group require a lot of control and discipline to ensure all children stay focused on the discussion and take part appropriately. Although requirements and needs were identified, further focus groups with smaller groups would have ensured a greater success during this stage of the project.

The system design was produced based on the set of requirements gathered; this ensured all requirements were successfully met in the resulting design. A design was produced for the entire system although only a section of this would be implemented during prototyping. The design was divided into conceptual and physical design as suggested by the methodology.
used. UML was used to identify flow of activity through the system hence supporting the navigational design. UML offered a level of abstraction, which allowed key functions to be identified successfully. The system design was evaluated through the development of a prototype, allowing users to interact with the system providing feedback.

The development environment was chosen effectively allowed a prototype to be implemented. The developer had previous knowledge of the chosen development environment through taught modules DB22, DB31, IN23, IN34 and also experience from outside the University. There were some initial problems with the server chosen to locate the system but these were resolved by liaising with the web hosting company. PHP and MySQL were used for the development of Ronny's Den, both being open source and free to use under the GNU software licence, they are suitable for the Rugby Club who were unable to finance new software.

The prototype offers many of the requirements identified although does not contain a full set of worksheets at this stage. However, the ability for staff to add their own worksheets has been included which means the system can be updated as required. Based on user testing and heuristic evaluation undertaken on the prototype, it is visible that the prototype offers enough functionality for testing purposes. The prototype does need further iterations before it will meet all of the requirements, namely: full administration for staff; interactive flash games and the ability to customise the appearance of the screen for each individual.

The initial problem identified the need for a computer based learning system to support disadvantaged children at the Leeds Rhinos Rugby Club Study Support Centre. A design for such system has been produced and a prototype developed. Indirectly, students involved in the focus groups and development of Ronny's Den have also benefited by being involved; a sense of importance and the chance to put forward and discuss options has helped students with communication and group working skills and may have also improved motivation; these were all identified as important areas for improvement within for disadvantaged children during Chapter 2.

8.3 Suggestions for Further Work

Although a development of Ronny's Den has been produced, further iterations to this development could be made to increase the functionality and ensure all requirements have been fully met; further evaluation would also need to be undertaken. Further functionality that needs to be included is:

- Full administrative control over user maintenance - this is currently limited to
deleting users on an individual basis.

- Interactive, Macromedia games should be developed to increase the interactive nature of the system.
- Collaborative tasks and activities between two or more people. This was identified as a “desirable” requirement in Chapter 4.
- Adaptive visual content based on user preference.
- The facility to print certificates and students work.
- The use of graphs on the student progress page to enhance the information displayed to the user. This could use the JPgraph library.

As well as the above functionality points that need to be included, there are also some possible extensions that could be made to the initial problem definition. These are:

- Research into adaptability techniques allowing content to automatically adapt based on each individual's progress.
- The inclusion of sound and animation to enrich the system further.
- Further subject areas and content could be included, increasing the range of available worksheets to help disadvantaged children in other areas of school work and not just with their work at out-of-school clubs.
- Extension of the system to cater for disabled students including those with physical and mental disabilities. This will raise a different set of design and interaction issues that will need to be evaluated.
- Extension to the system so that it is suitable for use with multiple study support centres throughout the country (e.g. Leeds United FC Study Support Centre).

### 8.4 Project Conclusion

Based on user and heuristic testing the implementation of Ronny’s Den has been developed successfully however further iterations are required to fix problems previously identified and to increase the range of functions. The project has also met and exceeded the minimum requirements as stated in Chapter 1; the project was also completed to the revised project schedule.
Bibliography


    Resource-based learning and the impacts of environment and learning cultures’,
   http://www.cie.uce.ac.uk/cirt/projects/past/rbl.htm

    (Eds.), User centered system design: New perspectives on human-computer interaction,


    Interaction’, John Wiley & Sons, America

    Open University, Great Britain

    Technology on Schooling’, Methuen & Co, London

    Special needs’, The Althouse Press, Canada

19. Utting D, (1999), Disadvantaged children 'at greater risk of adult mental health
    problems' http://www.jrf.org.uk/pressroom/releases/080897.asp
    (Accessed Novemebr 2003)

20. Warwick University Guide to Computer Assisted Learning,
    http://www.warwick.ac.uk/ETS/Publications/Guides/cal.htm

    Sage Publications Ltd
Appendix A: Personal Experience

Although the project has now been completed, to schedule and meets the minimum requirements set, there are several lessons learnt that I would consider for future projects.

One of the major points that became apparent during the development was the size of the system that needed to be completed. Although I was not looking at the educational content, just the functionality and user interfaces aspects, a lot more development time required than I had originally thought. It is important when starting out on a project of this type to ensure the problem is fully understood, and areas, such as technical implementation are not overlooked or assumed to be straightforward; this will have an effect on the project schedule; although this did not effect my project too much, and the schedule was still met.

During this project I undertook several focus groups with students from the study support centre. I soon learnt, after just one focus group, that it was extremely important to keep numbers of those involved lower than 8. The focus group with more users in was hard to control minute; the users involved had already been identified as having short concentration (Chapter 2) and this became ever more apparent during this initial focus group. Later focus groups, with smaller groups were more productive; participants made more constructive comments but were also easier to control; the flow of the focus groups were steady, at a pace set by me, the moderator.

Another lesson I learned during this project is that 3rd parties are busy people, and getting them involved (as was necessary in this project) will effect the schedule. During this project, I had to postpone users groups due to unforeseen circumstances with the Rugby Club; this meant stages such as evaluation were delayed. If I had allowed more time for user involvement stages, and aimed to get these stages completed at earlier dates, the knock on effect would have been drastically reduced.

For students considering continuing this project, or developing a similar project – either in size or content – I make the following recommendations:

- Ensure you identify the scope of the project and areas of the problem you will, and will not deal with. This will ensure you do not stray from your focused area.

- Ensure that when dealing with users and third parties, suitable numbers are used. This will ensure you are able to control the session or conversation. Make sure you are
well prepared before any focus groups or interviews to ensure you are in a position to control and lead the group otherwise users will stray into non-relevant areas.

- To aid with both the development and write up for the report, draft a "content page" early on. This will help you identify areas you may need to include and will force you to focus on the sections that need attention.

- If you are using 3rd parties during your project, ensure your schedule is flexible allowing plenty of time for user involved stages. It should be assumed that your users will be un-reliable (in the sense they may not be available when they initially say); this will have a knock on effect with stages directly after user involvement.

My overall experience of this project has been good; I have enjoyed having the chance to work with students and staff at the study support centre. Listening to their thoughts and opinions has reminded me of the important users are with relation to system development.

The chance to work on a project of this size has given me the opportunity to develop project management skills and report writing which have already proved vital with my work outside University.
## Appendix B: Project Schedule

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Appendix C: Staff Interviews

Notes taken during staff interview with Mr John Bedford:

**In your opinion, how would a computer based learning system aid the students at the centre?**

A computer based learning system will allow the course to be more adaptable to individual children study requirements. It would also allow the system to be more interactive, and hence interesting to the children compared to the current paper based teaching methods which often has children becoming bored and frustrated. I would like the system to monitor students work allowing us staff to easily identify those who need extra help. At the moment it is hard to identify struggling students as we do not have time to actually mark much of the work produced.

**What subject areas currently taught at the centre do you feel could be incorporated into such a system?**

The centre is based around maths, ICT, English and then the key skills such as communication and problem solving. I can see areas such as maths and English being ideal for such a system as many of our current worksheets being based around these subjects. Also, these often have “right and wrong” answers which would mean they are easy to mark. As the system will be computer based, ICT is something that will in-directly be included but doesn’t need specific “tasks” to be incorporated into the system.

**What features and tools do you think could be included to help with these subject areas?**

The children generally like learning maths in a very subtle way. The games available at http://www.mathsisfun.com/ have worked well in the past so it would be good if the system could include some interactive games like those.

Many of the children than come to the centre struggle with spelling and grammar and so some interactive worksheets that look into this area would be good. We have headphones available so the system could include a “listen and type” style worksheet for spelling.

Generally speaking, the children get the most benefit when they can observe the progress they have made so it would be good if the system offered the children feedback as to how well they are doing. Printable certificates are a big favourite with the children as they can take them home and show their parents.
How do you envisage the students using the system over the duration of their course with the centre?

The course lasts ten weeks, and each week we have a different theme or topic, normally based around the sports theme. The system should follow this by offering tasks that fit with the current weeks’ topic so that the students’ use of the system builds upon the work they do in the rest of the session. At the end of the course we give all students a portfolio of the work they produced during the course and so system should contribute to this.

How would you like to see the system supporting you, as a teacher and member of staff at the centre?

It is important that we can monitor the progress of each child at the centre and I would like a system of this sort to help me achieve that. It would be good if I could view the individual progress of each child to ensure they are completing the tasks properly. Also, I need to ensure that as a whole the course is benefiting the students which mean I need the overall progress of the students broken down into the main areas of maths and English. This helps us with the planning of future courses. I would also need to alter the content of worksheets and weekly tasks for different groups or sessions.

Are there any internal procedures that will effect how the system should be used either by students, staff or that could limit its integration within the course?

Students don’t have their own logon to the machines instead there is a separate username for each session e.g. MKS2 (Monday Key Stage 2). This means that students don’t have their own folder to store work in. Also, at the end of the course, any work that has been saved we generally delete. This is to keep out IT system clean and tidy. The set of topics and worksheets that the children will follow is decided at the start of the term before they arrive for their first session. This is generally the same for all groups but occasionally we have to alter them depending on the ability and experience of the children who are attending.

Can you identify any problems with using such a system within the centre?

The main hurdle is keeping the children interested in the task they are supposed to be doing. This system, like any other teaching method will have this problem.
Notes taken during staff interview with Mr Paul Dailey

In your opinion, how would a computer based learning system aid the students at the centre?

It would give them a chance to get more involved with a worksheet or task instead of it being very formulaic and paper based. As it can include multimedia, and involve the user I would expect the students to fine the experience more pleasant and would hope it would keep them interested and focused for longer. Will also give the students a chance to explore the areas they struggle with in greater detail instead of everyone following the same set of task routinely.

What subject areas currently taught at the centre do you feel could be incorporated into such a system?

Maths and English are both subjects that can be computerised, partially at least. They also offer plenty of opportunity for “fun” activities such as word and number games. The system should also cover the other areas we teach here at the centre which include healthy eating, fitness, drug awareness etc.

What features and tools do you think could be included to help with these subject areas?

Although many of the worksheet we get the students to do are to be done individually, we still try and include a few tasks, games, quizzes for example where they work together or maybe play against each other. It would be good if this system was able to offer a few two-player tasks or games. The students also benefit from being able to add the work they do to their portfolio, so a tool to print out the work they do and certificates to congratulate them would also be a beneficially feature.

How do you envisage the students using the system over the duration of their course with the centre?

I see the students using the system as part of each session but not for the entire session as other, group tasks, videos, sports activities are also scheduled. The students will use the system to support their development through the course, so each week should build on the previous and the student should always have an idea as to their progress on the course and see how well they are improving.
How would you like to see the system supporting you, as a teacher and member of staff at the centre?

As a member of staff at the centre I’d want to be able to alter the content of a course as the two different key stages have different tasks each week, and sometimes different groups of students will have different tasks based on their current ability. This depends on which schools they come from often.

Are there any internal procedures that will effect how the system should be used either by students, staff or that could limit its integration within the course?

The basic flow within the centre is we get the list of students from schools before the session starts; we add them to our register system and then plan the course for them. On their first session all students sit a maths test, and shortly will also be taking an English test (when we have written it!). Then each week the students undertake several tasks, either paper worksheet based, group work, individual IT work or sporting based activity like a tour around the training grounds. On the final day all students take a second maths test (and soon an English test). We compare the results of the two maths tests and primarily this that determines how well we feel a student has progressed. The students take a portfolio of results home with them to show their parents and teachers.

Can you identify any problems with using such a system within the centre?

Some of our students struggle with use of IT sometimes, finding it difficult to control the mouse for example. Although this isn’t a problem in itself, as getting the students to continue their IT use is good practice, it does mean some students are slower at getting the work complete. Because of this it’s important that realistic amounts of work are set but there should also be plenty of work for students that can get through the tasks quicker.
Appendix D: Student Focus Group Output (Requirements Gathering)

16 Students were present at the session, held at the Leeds Rhinos Rugby Club Study Support Centre.

Due to the large size of the group, reordering all comments during the focus group was difficult however, key points have been summarised below.

- All users had previous experience with Internet Explorer (the chosen application to be used for the system).
- Students agreed that they disliked completed paper based worksheets in class as they were dull to look at, black and white, hard to read photocopies. They also said that often, all the worksheets appear to be the same as each other and very routine based. Instructions were often to complex and involved too much reading. Some students stated that they didn’t like worksheets as they always had to do them twice, once in pencil and then once in neat once the teacher or student mentor had made corrections.
- Four (Mark, Claire, Sarah, Andrew) said they enjoyed using computers when they were working but didn’t like using the mice and keyboards as they struggling with using them. They complained they felt they were always left behind, as they were slower at using the equipment.
- They also stated that that they often found computer programs confusing and difficult to understand due to all of the options available.
- Students said they would like the site to be colourful and visually interesting.
- They all said a sporting theme would be good – so using the colours of the Rhinos Rugby club could be an idea.
- One student (Sophie) said she liked the way Yahoo Mail let her change colours and basic structure based on her own preferences.
Appendix E: System Design Sketches and UML

**UML activity diagram showing the activities staff users can do.**

**UML Use case diagram showing how users interact with the system.**
Login Screen

Main Page – Home Page

Example Worksheet (this page would appear in the “main content” area of the main website)
Useful Web Links Page (this page would appear in the “main content” area of the main website)

![Web Links Page]

Student Progress Page (this page would appear in the “main content” area of the main website)

![Student Progress Page]

Staff Progress Page (this page would appear in the “main content” area of the main website)

![Staff Progress Page]
Add Worksheet (this page would appear in the “main content” area of the main website)

The user clicks this button to add another question and answer to the worksheet until they are finished. Click ADD to submit the completed new worksheet when done.

Add Student (this page would appear in the “main content” area of the main website)

These options allow the user to alter the way in which students are listed

Maintain Student (this page would appear in the “main content” area of the main website)
System Navigational Structure

Login Page

Main Page

Admin section visible to admin users only

Worksheets

User Progress

Admin

Full User Progress

Worksheet Admin

User Admin

URL Admin

Web Links

Add Web Link

Results

Full User Progress

Worksheet Admin

User Admin

URL Admin

Admin section visible to admin users only
Appendix F: Database Design

All databases were prefixed with lrrcss so that they are easy to identify on the database server.

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lrrcss_task

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The Design and Development of Educational Software for Disadvantaged Children.

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The Design and Development of Educational Software for Disadvantaged Children.

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Appendix G: Student Focus Groups Output (Prototyping)

- Focus Group included 8 users from the centre. The session was held at the Rugby Club study support centre. Main points raised are summarised here.

- The prototype offered limited functionality.

- All students agreed that the system was generally good on first appearance and as they had expected.

- Three students (Chris, Claire, Andrew) said they would like a more interesting design down the side of the page for navigation, curves for instance.

- All students agreed the system would benefit them and help them complete the worksheets to a greater standard.

- No student reported any problems they had with using the system.

- Students all said they would have liked to see interactive games, at least one a week.

- The first worksheet was familiar to students as they had completed it in paper format during a previous session at the centre.

- Several students commented on the worksheet being easier (Chris, Andrew, Claire, Sarah, Mark)

- All students said they preferred doing the worksheet on the computer as it was more interesting

- Students suggested that the web links page have an option allowing them to select the desired category.

- Student mentors said they noticed that all the students, at some point attempted to click the pictures down the side of the screen – which implied they thought they were buttons or would take them somewhere.
Appendix H: Prototype Screen Shots

login page

main page. Shows pictures down left but also navigation, and intro text at the top of the page. Based on evaluation, the bulky text was removed for the final iteration.
The Design and Development of Educational Software for Disadvantaged Children.

A sample short answer question worksheet – also demonstrates the warning at the top to say the user has already completed this worksheet.

A sample user progress screen.
the web links page – with the option to search and the option to add new links.

the web links results page for the education category.
Appendix I: Heuristic Evaluation

You will act as usability experts who evaluate the site following given criteria. You have to rank to what degree each criteria has been satisfied.

You are a student (aged approx 12yrs) at the Leeds Rhinos Study Support Centre. You are using the system to complete a series of worksheets whilst at the centre. You have little patience with computers and are easily frustrated when things don’t work as you expect. You will also have limited concentration span and get sidetracked easily. You should consider these points when assessing Ronny’s Den.

1. Spend some time to familiarise with the prototype by performing two user tasks.

   Task 1: Login to the system (username: dhemmings password: dhemmings) and attempt to complete today’s main worksheets. You don’t have much time to spend on these tasks as you are going on a tour of the Rugby ground in 30 minutes.

   Task 2: You are back from the tour of the rugby ground and five minutes to spare. You want to see how well you have done to-date whilst you have been at the centre. Whilst you have some spare time you decide to browse the recommended web links for something that interests you.

   Note that in both tasks you are assessing a prototype, i.e. it should be possible to get an idea how the system would function judging by the interface, and it is not necessary that a fully fetched system exists.

2. Go through the heuristic evaluation criteria to assess the prototype.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Remarks</th>
<th>Ranking (0-Poor 5-Excellent)</th>
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<tbody>
<tr>
<td><strong>Navigation &amp; Speed</strong></td>
<td>- Is it easy to find your way round the site, is there any guidance, e.g. navigation bar, menus.</td>
<td></td>
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<tr>
<td></td>
<td>- Are the most frequent tasks performed quickly, are there any cumbersome operations.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Are there deep hierarchical menus.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Are the links recognisable and consistent.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Can the users always find out where they are, can they get back to home page.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Information Display</strong></td>
<td></td>
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<tr>
<td></td>
<td>- Are users provided with a reasonable amount of detail for each task. Are they overloaded with much detail. Is additional information, when needed, easy to find and access.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Is the information provided suitable. Are there appropriate descriptions and pictures.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Is the layout well-structured and easy to follow. Is there too much or too little text.</td>
<td></td>
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<tr>
<td></td>
<td>- Is the site aesthetic and pleasing for the user. Are the colours appropriate. Are there any inappropriately used animations that distract users.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Are there any long pages. Do they have lots of white space or are they full of texts or lists.</td>
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</tr>
<tr>
<td><strong>Consistency</strong></td>
<td>- Are all pages in the same style.</td>
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</tr>
<tr>
<td></td>
<td>- Are the same buttons, fonts, menu styles, etc. used across the site.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Are they used in the same way.</td>
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The Design and Development of Educational Software for Disadvantaged Children.

<table>
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<th><strong>Accessibility</strong></th>
<th><strong>Note that for this criteria you need to look at the source code.</strong></th>
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<tbody>
<tr>
<td></td>
<td>- Are menus used, named, and positioned consistently.</td>
</tr>
<tr>
<td></td>
<td>- Have links been used consistently.</td>
</tr>
<tr>
<td></td>
<td>- Can the site be used with all images being disabled.</td>
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<tr>
<td></td>
<td>- Have <em>ALT</em> texts been provided for and buttons.</td>
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<td>- Do the hypertext links have meaningful texts.</td>
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<td>- Is the structure of each page easy to follow.</td>
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<td>Have header tags (&lt;h1&gt;, &lt;h2&gt;, &lt;h3&gt;) been used appropriately.</td>
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Heuristic testing adapted from GI11 coursework 3 marking scheme, 2003 with the permission of Dr V Dimitrova