Technical Report

Undergraduate Dissertation: An Investigation into Second Language Acquisition and Tutoring Systems for Children at Key Stage 2

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An Investigation into
Second Language Acquisition and
Tutoring Systems for Children
at Key Stage 2

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Batchelor of Science in Computer Information Systems with Honours
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An Investigation into Second Language Acquisition and Tutoring Systems for Children at Key Stage 2

Submitted by: Laura Benton

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Declaration
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Abstract

The government has recently developed a National Languages Strategy (2002) stating that every child at Key Stage 2 should have the opportunity to study a foreign language. In response to this there will be a growing requirement for teaching aids to support this new element of the curriculum. A computer-based tutoring system is one way of fulfilling this need and this project aims to investigate the possibilities this offers for second language acquisition.

The theoretical background to child language learning is explored as well as computer-based learning techniques and human-computer interaction issues. Potential stakeholders are engaged and empirical evidence is gathered from them through interviews and observations. The requirements for the proposed system are then established using this evidence along with the findings from the literature.

A secondary aim of the project is to investigate child-centred design and the various methods and techniques for achieving this. Therefore children have been involved in both the design and evaluation of the project. The benefit of this approach is reflected in the evaluation results with the children demonstrating both a positive user experience as well as an increase in learning after using the system. It has been concluded that there will be a real need for computer-based language tutoring to support classroom-based learning in the future, and with further research and development the current prototype shows the potential to fulfill this need.
Accessing the prototype

The high fidelity prototype that has been developed during this project can be found online at the following web address:

http://people.bath.ac.uk./cs3ljb/Tutor/main.cfm

To access the unit that has been implemented click on the footprint entitled ‘Numbers’.

Please be advised that you will need to have Adobe Flash Player installed on your PC to view the system fully. Adobe Flash Player can be downloaded free from the Adobe website via the following link:
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Chapter 1

Introduction

There is currently no statutory requirement for children to be taught modern foreign languages at Key Stage 1 and 2 (ages 4 - 11). However the government has developed a National Languages Strategy, which it plans to implement by 2010, that states:

“Every child should have the opportunity throughout Key Stage 2 to study a foreign language and develop their interest in the culture of other nations. They should have access to high quality teaching and learning opportunities, making use of native speakers and e-learning. By age 11 they should have the opportunity to reach a recognised level of competence on the Common European Framework and for that achievement to be recognised through a national scheme.”

Guidelines for sample schemes of work for modern foreign languages are provided on the DFES website, but as MFL is not a compulsory part of the curriculum before Key Stage 3 (secondary school level) there is no requirement for primary schools to follow this if they choose to teach languages at Key Stage 1 or 2. Therefore there is currently a huge variation in the amount and methods of teaching MFL in primary schools, if they are taught at all.

E-learning is specifically mentioned within the National Languages Strategy as a method that the government would want schools to use when the strategy is put into place in the next few years. Although a wide variety of software already exists for learning foreign languages, teachers would be looking to use software to complement the new syllabus specifically set out by the government. It is essential the software, as well as containing the correct content, is designed with children in mind to maximise the learning potential from the software.

1.1 Aim

The aim for this project is to investigate second language acquisition for children as well as the techniques for involving children in the development process of an interactive product. The findings will then be applied to designing a computer-based language tutor, which fulfils the specific language learning needs of children at Key Stage 2.
1.2 Objectives

The key objectives of the project include:

- To investigate second language acquisition and the role of the tutor.
- To use the guidelines for modern foreign language teaching at Key Stage 2 in the National Languages Strategy.
- To evaluate existing language learning tools aimed at children.
- To research human computer interaction issues particularly concerning child computer interaction.
- To engage stakeholders from a representative primary school who will actually be using the tutoring system and identify their requirements for the system.
- To find out about the current teaching methods for foreign languages in the sample school.
- To use the stakeholders’ requirements to create prototype designs.
- To build prototype versions of the tutoring system to allow a representative sample of children from Key Stage 2 to test the main functionality of the system.
- To design the tutoring system with scope for further enhancements to include different levels and languages.

The next chapter will investigate the existing literature within the scope of the project.
Chapter 2

Literature Survey

2.1 Introduction

“Those who cannot learn from history are doomed to repeat it” George Santayana.
It is important to first consider any previous work that has been done within the problem domain, as there is little point in re-inventing the wheel and vital lessons can be drawn from these findings. Researching related literature also provides a good foundation and a crucial direction for the project.

The computer-based tutor will be used by primary school children at Key Stage 2 (aged 7 – 11); therefore it is important to look at the learning styles of children in this age group and particularly the way in which they acquire a second language. Additionally, to enable the child to learn effectively from the tutor, the various ways in which a child can learn through ICT need to be explored. Finally, as child-computer interaction differs significantly from adult-computer interaction the various interface design principles need to be investigated, specifically in relation to child users.

2.2 Learning

Woolfolk (2001) states that learning occurs when experience causes a relatively permanent change in an individual’s knowledge or behaviour. The change may be deliberate or unintentional, for better or for worse. To qualify as learning, this change must be brought about by experience – by the interaction of a person with some aspect of his or her environment.

In a classroom environment where the individual learner’s abilities need to be taken into consideration, learning can be made easier or harder depending on what that individual is capable of. It is important to strike a balance in the level of learning. If it is too easy the learner may become bored, but too hard and the learner may become discouraged.

There are several different theories relating to the way in which people learn and their implications to a computer-based tutor, which shall be explored in the following sections.
1.2.1  Behaviourist Theory

Behaviourism is the theory of ‘learning by association’, and involves an event that activates a particular behaviour, known as a *stimulus*, that in turn triggers an observable reaction to that event, known as a *response*. One of the most well known behaviourists was Skinner, who carried out the major work in establishing the concept of operant conditioning.

**Skinner**

Skinner believed that not all human learning happened automatically, as most behaviours were actually carried out voluntarily. He proposed the idea of people actively ‘operating’ on their environment, and the consequences of an operant strengthening their behaviour, also known as reinforcement.

Skinner supposed that the occurrence of this ‘operant conditioning’ reinforced the correct or desired behaviour, and taking no action after incorrect or desired behaviour would gradually extinguish it. Many computer-based tutors have operant conditioning as the basis for their design.

2.2.1  Cognitive Theory

In contrast cognitive theory is concerned with the way in which the human mind thinks and learns. The learner is seen as an active participant in the learning process. There have been a number of influential theorists in the field of cognitive psychology including Piaget, Vygotsky and Bruner.

**Piaget**

Piaget was a theorist in developmental psychology and was concerned with the way in which a child’s mental development was influenced by the world around them. He believed that learning occurred through taking action to solve problems, and so the knowledge gained from such action is actively constructed rather than innate. According to Piaget there are two different ways that development can happen as a result of an activity, which are:

- **Assimilation** – this happens when an action takes place without any change to the child; for example using a fork in the same way as a spoon.
- **Accommodation** – this involves the child adjusting to features of the environment in some way; for instance spiking the food rather than scooping it up in the same way as a spoon.

A child’s thinking involves a gradual growth of knowledge acquisition to knowledge construction, but which includes certain fundamental stages, as before the child reaches certain ages they are capable of some things but not others. The four fundamental stages in a child’s development include:

1. **Sensori-motor** (0-2 years)
2. **Pre-operational** (2-7 years)
3. **Concrete operational** (7-11 years)
4. **Formal operational** (11-adult)

The concrete operational stage (Key Stage 2) involves “mental tasks tied to concrete objects and situations” Freedman (2006). At this stage the child is able to solve hands-on problems, but is largely dependent on previous experiences. The child has a very high level abstract reasoning ability, and is also able to classify objects by grouping them into categories. The child also has an understanding of reversibility, which enables them to mentally cancel out a change that has been made. Therefore, with regard to a computer-based tutor, a child at this developmental stage would be able to cope with functionality involving the concept of reversibility.
One thing that Piaget failed to take into consideration was the learner’s social interaction. He took the view of the child as an active learner alone in a world full of objects, whereas Vygotsky, another cognitive theorist, believed the child to be an active learner in a world full of people.

**Vygotsky**

Unlike Piaget, Vygotsky recognised learning as a social phenomenon, placing language and communication at the heart of the child’s intellectual and personal development. He believed that adults mediate the world for children, thus making it more accessible and allowing them to understand more than they could on their own.

Vygotsky developed the principle of a Zone of Proximal Development (ZPD) which stated that intelligence was better measured by what a child could do with skilled help. For instance offering the first step in a solution or providing a leading question. He found that children at the same developmental point would make different uses of the same help given by an adult. Using the idea of ZPD adults are able to mediate the next stage in a child’s learning. Bruner carried out investigations in a similar area, looking at how adults use language to carry out this mediation, enabling the child to solve a specific problem. It would also be possible for a tutor to offer differing levels of mediation to support the child when completing a computer-based task.

**Bruner**

One of the main concepts Bruner developed, which adults use when mediating a child’s learning, is that of scaffolding. Scaffolding is “talk that supports a child in carrying out an activity” (Wood, Bruner and Ross 1976).

The benefits of using scaffolding are that it encourages children to become more interested in a task. It helps simplify the task by breaking it down for the child. It keeps the child on the right track by reminding them of the important aspects and goals of the task. It shows the child alternative ways of completing the task and it can help control any frustrations the child may be having. Good scaffolding should help support the individual needs of the child and should be adjusted as the child becomes more competent in a task. A computer-based tutor would also be able to use scaffolding, which could be turned on or off depending on the amount of support a child requires for a specific task.

Bruner also developed the notion of formats and routines, which allows scaffolding to take place. By applying a familiar routine to a new task a child can feel excited by the fact that they are attempting something new, but they still have the security of a routine they have been through before, which stops the child from feeling lost.

A number of different teaching methods can be drawn from both Behaviourist and Cognitive theories, a combination of which can be incorporated into the classroom-learning environment.

### 2.2.2 Teaching Methods

Behaviourism uses the techniques of reinforcement and punishment. When the child exhibits a desired behaviour in relation to their learning, which the teacher can then reinforce by praise or a reward of some kind to ensure the behaviour will be repeated. This will help motivate the child. When the child exhibits an undesired behaviour punishment can be used to help suppress the behaviour from happening in the future.
A behavioural-based teaching method that can be used to support this practice is that of cueing and prompting. Cueing provides a stimulus that sets up a desired behaviour and prompting is a reminder that follows a cue to make sure the person reacts to the cue (Woolfolk 2001). This method helps a child remember to carry out a particular behaviour at a specific time, although prompting should only be used when absolutely necessary to ensure the child doesn’t become dependant on it.

Cognitive theory also presents a number of valuable teaching techniques which include understanding and building on children’s thinking, in particular the way in which they approach solving problems. This enables the child to learn in the most appropriate way. The ‘magic middle’ of teaching (Woolfolk 2001) needs to be considered, as it is essential the level of teaching ensures the child is neither bored nor frustrated. Using material that can be understood on several levels is a good way of meeting the learning needs of an entire class.

Social-interaction with teachers and peers is also an important way of teaching a child, as this enables their thinking to be tested out, for the child to learn from the way in which others do things and to be given feedback. In particular adult guidance, where using techniques such as scaffolding provides support for a child’s learning, but also allows them to learn on their own.

Although both Behaviourism and Cognitive theory explore the way in which a child learns and present ways to maximise learning potential, why exactly does a child want to learn? More specifically, what motivates a child to begin the learning process and to continue learning throughout their lifetime?

### 2.2.3 Motivation

Motivation can be defined as “an internal process that activates, guides and maintains behaviour over time” Freedman (2006). Two ways of classifying motivation are:

- **Intrinsic Motivation** – this is motivation that is generated from within an activity, where the activity itself generates rewards such as interest or enjoyment. The cognitive view of motivation tends to be intrinsic, as it is believed that behaviour is determined by a child’s thinking, so if they are interested in something the child is more likely to want to carry on with an activity to enable them to learn more.

- **Extrinsic Motivation** – this is motivation created by external factors, outside the activity itself, and relates to what the child will gain from the activity such as avoiding punishment or pleasing someone else such as a teacher. In contract to the cognitive view, the behaviourist view of motivation is an extrinsic one, as it is thought that a child’s behaviour is encouraged or discouraged using incentives, rewards and punishments.

A key difference in the two theories is the fact that the cognitive view allows children to exercise a choice in the way in which they behave and therefore gives them control over their actions. Whereas the behaviourist view is a lot more constrained and sees a child’s actions as a result of external factors such as rewards, rather than that of their own free will.

Different children are motivated in different ways, two such ways are:

- **Achievement Motivation** – children will differ distinctly in their need to achieve success in a given task. Atkinson (1964; cited by Williams & Burden, 1997) stated that achievement motivation for any individual could thus be determined by the relative strength of the tendency to approach a task compared with the strength of the tendency to avoid the task. There could be a number of factors that affect a child’s need to achieve including the competitive environment of the education system where success is often rewarded with praise and high grades or the expectations of a child’s parents. A child could also set out to avoid a task because of the stressful nature of the task, for instance an exam, or the shame that failure in the task would bring.
- **Optimal Arousal** – there is a problem with some of the other motivation theories in the fact that they make the assumption humans are constantly striving to be a settled state of being rather than a stimulated one. Optimal arousal is a term defined by Hebb (1959; cited by Williams & Burden, 1997) as a state in which humans function best without having to meet any other basic needs. This takes into account children being motivated by curiosity and novelty, both of which are common occurrences in a classroom environment.

There are many factors that influence motivation and the following should be taken into account when considering a child’s motivation, and ultimately their probability of achieving success, when carrying out a task:

- The child’s interest in actually carrying out the task itself.
- The value of the task in the child’s view, for instance the relevance of the task to the child as an individual and their anticipated value of its outcome.
- The level of control the child perceives over the outcome of the task.
- The child’s self-belief in their ability to be able to cope with the task.
- The child’s awareness of their strengths and weaknesses in regards to the task.
- The child’s personal definition of success or failure of the task.
- The attitude the child has in relation to individual aspects of the task.
- The child’s level of confidence or anxiety about the task.
- The developmental age and stage of the child.

There are also a number of other external factors that could affect a child’s motivation which include:

- Significant others such as teachers, parents and peers.
- The nature of the interaction with the significant others such as the amount of praise or punishments.
- The learning environment and the amount of resources available to aid learning.
- Cultural factors and societal expectations.

As each and every child will be motivated to learn in different ways, it is important to incorporate a combination of motivational techniques in the classroom environment for instance balancing praise for those striving to achieve success with punishment for those seeking to avoid the tasks completely. It is also important that any kind of technological support adheres to these techniques, to keep the child motivated when using something such as a computer-based tutor.

### 2.2.4 Learning and ICT

The use of ICT is becoming more and more common within education and the children currently at Key Stage 2 (ages 7-11) will have been exposed to ICT throughout their school life. One of the main benefits of computers are the one on one learning they offer the child, which the majority of the time is not available within the classroom environment due to the large class sizes. This enables the child to have a level of control over their own learning, and the software can be tailored to suit their current abilities. Computers are also able to present abstract concepts in a visual way to children, at the concrete operational stage, who often struggle with the understanding of these concepts.

There are many different types of educational software that can be incorporated into the curriculum. Kemmis et al. (1977; cited by Freedman, 2006) introduced a classification of educational software called the Paradigms of CAL (Computer Assisted Learning), which include:

- **Instructional paradigm** – here the computer acts as a patient tutor. The learner is presented with a fixed amount of information in a highly structured way and is sometimes asked questions about it. This is useful in small amounts when presenting a new concept, but needs to be combined with other paradigms to keep the child motivated and ensure they are actually taking in the information they are presented with.
- **Revelatory paradigm** – here information is revealed to the learner as they explore the program. This can include simulating different scenarios using rules built into the system, but based on the conditions specified by the learner. This aids the child in their understanding of the concept by giving them some level of control over their learning and also keeps them interested in the task.

- **Conjectural paradigm** – here the learner can model a situation using their own rules, and then change these rules to explore different ways in which the model can work, for instance a spreadsheet or a programming language. Although this gives the child flexibility over the way in which they learn, care needs to be taken to ensure that the program doesn’t become complex for the child to use. Also certain restrictions need to be put in place to ensure the child is still going in the right direction with regards to their learning goal.

- **Emancipatory paradigm** – here the program helps the learner to carry out a task that might be tedious or difficult otherwise. This might be helpful to a child in writing text as they may find a keyboard easier to use than actually writing on paper.

Ensuring the software is at the correct level for the child using it is one of the most important considerations when designing a computer-based tutor. One way of tailoring software to specifically suit individual children is using an Intelligent Tutor System.

**Intelligent Tutor Systems**

Intelligent Tutor Systems (ITS) are a particular type of educational software, which have an element of artificial intelligence. As the child uses the ITS it tracks their progress, so it can identify the areas they are struggling with and then provide feedback and hints to help the child improve and understand in these areas. This ensures the child’s learning is concentrated in the areas they need extra practice and allows for maximum learning benefit to be gained from the software.

The ITS must have knowledge of the domain, which is the curriculum subject it is covering, so the correct information is presented to the child. Also it must have knowledge of the learner, which would be the child who is using the ITS, to ensure the learning is at the appropriate level i.e. not too easy and not too hard. Finally the ITS must have knowledge of the teaching strategies so the information is presented in a way in which the child is familiar and complements the teaching style that is used in the classroom.

Figure 2.1 shows the Intelligent Tutoring System process, where a child is presented with a problem and given feedback based on their solution to the problem. The whole process is an iterative one, with the tutor system storing the outcome of each iteration.
Intelligent Tutor Systems are useful in a classroom environment as the level of ability between children can differ quite dramatically. The tutor system allows each child to work at a level specifically appropriate to them, something that is not always possible using conventional teaching styles.

Although intelligent tutor systems offer one solution to building a computer-based tutor system they also present a series of problems. Firstly information needs to be gathered about the individual children by observing or questioning them. This information would then have to be built into the system as a ‘child model’ along with an ‘expert model’ which would provide a correct solution to each task. This entire process would be very complex and time-consuming. There are also the problems involved in updating the model, and when this update should take place, as this will influence further sections of the model. If the model is not updated regularly then the child could be presented with unsuitable material and this could cause the child to make mistakes, causing additional problems. One possible solution is giving children access to the model and allowing them to perform the update themselves. However this does present a further problem, due to the fact that in order to perform this action children need to be active in understanding their own problems. This is an important research area, but is considered to be out of the scope of this project.

“Tell me and I forget. Show me and I remember. Involve me and I understand.” - Chinese Proverb

One of the main points highlighted in this section is that children can not learn by just being told information they need to be able to participate in their own learning experience. Computer-based tutoring systems offer children a unique opportunity for learning, something that isn’t available in a conventional classroom-based environment. This style of learning is particularly valuable in the case of Modern Foreign Languages, which will be explored in the following sections.

2.3 Second Language Acquisition

Second Language Acquisition (SLA) is “the process by which people learn languages in addition to their native tongue(s)” (Wikipedia, 2006). Second language can be used to describe any additional language that is learned after early childhood. It has been commonly theorised that the successful acquisition of a second
language is more likely before puberty, also known as the ‘critical period’. The conflicting views on this theory shall be investigated in the following sections in relation to the government’s current proposals to introduce modern foreign languages into the curriculum at Key Stage 2.

2.3.1 Modern Foreign Languages at Key Stage 2

There is currently no statutory requirement for modern foreign languages to be taught to primary school aged children (Key Stages 1 and 2), although the government has now put forward proposals to introduce MFL at Key Stage 2 (ages 7-11) by 2010. It has been developed into the National Languages Strategy and it states that:

“Every child should have the opportunity throughout Key Stage 2 to study a foreign language and develop their interest in culture of other nations. They should have access to high quality teaching and learning opportunities, making use of native speakers and e-learning. By age 11 they should have the opportunity to reach a recognised level of competence on the Common European Framework and for that achievement to be recognised through a national scheme.”

As many schools will not have taught a modern foreign language before there are a number of factors they need to consider before introducing MFL into the curriculum. Firstly the choice of language and the aims and objectives of the teaching, so the class teacher has a clear goal in what each child should have learnt, or at least been exposed to, by the end of the year. Also the amount and frequency of the teaching time, should it be little and often, or a significant amount of time once every so often. Finally the teacher needs to consider the continuity and progression of the language learning, throughout Key Stage 2 and to ensure it links up with the current Key Stage 3 curriculum to ensure a smooth transition from primary to secondary.

The availability of suitably trained teachers is one of the obstacles that a school intending to introduce MFL may encounter. This is where the use of ICT will be extremely useful as the children can use the computer to practice, rehearse and support all areas of language learning particularly the speaking and listening skills that would be concentrated on at the Key Stage 2 age group. E-Learning is also specifically mentioned in the National Languages strategy as ICT is underdeveloped in over three quarters of schools but it is an important skill for a child to have, and incorporating ICT into MFL allows for cross-curriculum learning to further develop both sets of skills.

The National Languages Strategy also proposes that “Primary children at Key Stage 2 should have an entitlement to high quality teaching and learning that instils enthusiasm in learning languages, is based on a flexible experience which makes the most of ICT and sets a foundation for future learning and success” and that “Teachers must harness the power of ICT to develop the ability of pupils, engage learners and provide access to a wider range of language experiences”. The strategy highlights on numerous occasions the use of ICT in learning a MFL, which demonstrates the essential part it plays within the curriculum at Key Stage 2.

A computer-based language tutor would fit perfectly into the vision the government has for transforming the MFL language curriculum at Key Stage 2. In developing such a tutor the precise way in which a child acquires a second language needs to be taken into consideration to enable the tutor to be tailored to their learning needs.

2.3.2 Methods of Language Acquisition

The theories of learning outlined in the previous section can also be applied, more specifically, to explain the language acquisition process of a child, whether language is ‘caught or taught’ and also the differences concerning second language acquisition.
Behaviourist Model

In the Behaviourist view of learning a child would be encouraged to imitate an adult’s language and would be positively reinforced by being given attention or praise. Punishments may simply be in the form of explicit correction by the adult.

The Behaviourist model of language acquisition is not widely thought to be able to explain the entire process of language acquisition, but some aspects can be drawn from the model including:

- The use of imitation, which plays a part in the acquisition of phonology, as a child’s pronunciation is often similar to their parents.
- Some social and pragmatic aspects of language, such as politeness strategies.

One of the main problems with this model is that it assumes that all children are motivated to speak in the same way, and this does not explain the way in which some children apply grammatical rules to language in the wrong way. For instance using ‘eated’ instead of ‘ate’, the child cannot have acquired this language through imitation, but it could be explained using the cognitive view of language acquisition.

Cognitive Theory

Wyse and Jones (2001) state that in a cognitive approach the learner is seen as an active participant in the learning process, using various mental strategies in order to sort out the system of the language to be learned. In this view the child is not simply imitating the language they hear, but understanding and applying the rules and structures of the language.

The work of Chomsky fits in with this view of language acquisition. Chomsky proposed that language is acquired as a set of grammatical rules. This means not only does the child understand the meanings of individual words, but also the grammatical rules of structuring a sentence.

Chomsky developed the idea of a Language Acquisition Device (LAD), which is an assumed innate element of a child’s brain, allowing the child to understand and create new appropriate utterances based on language structures and patterns the child has been exposed to. This would explain the child producing expressions such as ‘eated’, which could not possibly have been learnt from an adult. Although Chomsky insists that language acquisition is biologically inevitable, Bruner suggests that a LAD could not function without the aid of adult, as there is no one to provide examples and feedback to the child.

Piaget’s view of language acquisition is that a child will not progress to the next stage in the language development until they have reached a specific intellectual level. For instance within the concrete operational stage of development (aged 7-11) a child would not be able to acquire the linguistic means to express more abstract concepts until they had progressed to the next developmental stage and can actually understand the logic behind the concept first. This view fits in with the Input Hypothesis, developed by Krashen (1985), which is part of an overall theory consisting of five hypotheses of second language acquisition.

The Input Hypothesis and Second Language Acquisition Theory

It is thought that there are two different ways of developing ability in a second language, through acquisition and through learning, which is also known as the Acquisition-Learning Hypothesis. Acquisition is a subconscious process, and is similar to the way a child acquires their first language. In contrast learning is considered to be a conscious process only possible after the first language has been acquired, as the child now understands about grammatical rules and structures, and can apply this knowledge when learning an additional language. Learning would be the process of developing ability that would be encouraged and supported within the classroom-environment.
Corder (1967; cited by Krashen, 1985) proposed the **Natural Order Hypothesis** where the rules of a language are acquired in a predictable order, some rules earlier than others. This order is not necessarily the order in which they are taught in a language class, so children should not be expected to understand some rules before firstly being taught others.

The **Monitor Hypothesis** relates to how language acquisition and learning are actually used. A child’s ability to speak in another language is assumed to be a subconscious process which comes with acquired competence, whereas conscious knowledge gained through learning can only be used to ‘monitor’ this language by correcting or changing the language output before the child speaks.

The **Input Hypothesis** states that “humans acquire language in only one way – by understanding messages or by receiving comprehensible input” Krashen (1985). It is possible for a child to understand language-unknown grammar if they use context such as pictures, objects or discussion of familiar topics. Input is the essential ingredient to language acquisition, and as long as enough input is available the grammar is automatically provided, so the child need not be supplied with this information explicitly. Krashen asserts the importance of Chomsky’s LAD in this process. The hypothesis also states that the child is restricted in what they can actually learn; they progress along the ‘natural order’ and can only acquire language structures at the next stage of development. This means if a child is not ready to learn a specific structure there is little point in trying to teach it to them. Therefore it is important to understand the developmental stage at which the child is currently and only present them with language appropriate to that stage.

The **Affective Filter Hypothesis** is a type of mental block that stops a child from meeting their full language acquisition potential from a given input. This could occur because the child feels unmotivated and is lacking in self-confidence due to the fact the child feels an environment such as a classroom will expose their weaknesses. This is a situation that could be solved by the use of a computer-based tutor.

It is commonly thought that second language acquisition comes more naturally for a child than it does for an adult, but does the age of the language learner really affect the level of success in language acquisition?

**Age of Acquisition and The Critical Period**

One of the most important hypotheses discussed in the previous section relating to the age of second language acquisition is the Affective Filter Hypothesis. According to Seliger, Krashen and Ladefoged (1982) the affective filter gains dramatically in strength around puberty. Although older learners may initially progress more quickly due to a greater experience and knowledge of the world, and their superior conversational management skills, children are less worried about the failure when speaking a second language aloud and also of the opinions of their peers. This means they benefit far more from participation in the classroom and therefore attain more success over time due to being able to practise their spoken skills more extensively in this way.

The age before a child reaches puberty is thought of as an important time in relation to language acquisition and is often referred to as the ‘Critical Period’. The Critical Period Hypothesis states that there is a “limited developmental period in which it is possible to acquire a language, be it L1 (first language) or L2 (second language), to normal native-like levels. Once this window of opportunity is passed, however, the ability to learn language declines” Birdsong (1999). Although this hypothesis does not say it is impossible for one to learn a language once the critical period has passed there is evidence to suggest that most adult learners do not manage to achieve the same native-like success in acquiring a second language as a child learner does. This is due to the fact that a child is still able to use the mechanisms that assisted them with first language acquisition.

Birdsong (1999) proposes a number of possible reasons for the existence of this critical period in language learning:
Maladaptive gain of processing capacity with maturation – Newport (1990, 1991; cited by Birdsong, 1999) suggested that children are more suited to language learning because of their cognitive immaturity which forces them to only focus on one thing at a time. It is thought this single-minded concentration may be a necessity for language learning.

Use it then lose it – Pinker (1994; cited by Birdsong, 1999) supposes that children have a language learning faculty within their brain to enable them to initially acquire their native language. This faculty can also be used in second language acquisition during childhood, but is lost after the critical period as it has served its purpose and it would be inefficient to retain it.

Use it or lose it – a slightly different version of the previous theory that supposes as long as the language learning faculty is in continuous use it will not be lost. This means that as long as a child begins learning a language before the critical period they will still be able to acquire a native-like competence in the language going into adulthood.

Learning inhibits learning – this involves the theory that during the learning process a ‘weight’ is committed to a particular configuration of knowledge, which affects a person’s overall understanding of the language structures. These weights are most flexible at early stages of learning and after a certain point of no return the commitment of a specific weight cannot be undone. This suggests once a child has learnt something, after the critical period has passed it may be extremely difficult to correct a wrong conclusion about a specific language structure.

Based on the evidence presented above a child’s thought processes and learning style are well-suited to language acquisition. This is why the government’s strategy to start the teaching of modern foreign languages at Key Stage 2, before secondary school, when the child is still in the critical period for language learning, is an important factor in improving the overall success of second language acquisition in this country.

A key consideration when implementing a new subject into the curriculum is the way in which the material will be taught, and the younger age group of the language learner needs to be taken into account when developing this.

2.3.3 Second Language Teaching

There are a couple of preconceptions that often occur with regard to teaching a foreign language to children. One is that teaching a child is straightforward; on the contrary the teacher needs to have a full appreciation of a child’s learning process and be able to help them develop their understanding of the language, which often involves quite formal concepts the child is unfamiliar with. The teacher also needs to help keep children focussed and motivated in a way that would not be necessary for adult learners. The second preconception is children only need to be taught simple language. Children can only learn what they are taught and it is important they are challenged to enable them to meet their full language learning potential.

Some of the teaching methods discussed previously can be adapted to specifically accommodate foreign language teaching. Scaffolding can be used to help the child keep in mind the overall goal of the task when the child is concentrating on one particular aspect of the foreign language. Formats and routines can also be incorporated into this to allow the child to make sense of new language based on familiar experiences.

One of the main considerations when teaching a foreign language to children is the fact that their first language learning may not yet be complete. This means there are certain parts of a foreign language that cannot be taught until they have first been acquired in the child’s native language. Related to this is a theory called the Competition Model which was developed by Bates and MacWinney (1989; cited by Cameron, 2001) and explains how first language learning may affect subsequent second or foreign language development. Babies learn to use a series of ‘cues’ within a language to interpret the meaning of what is being said. Later on a child will use the same strategy to make sense of a second language, looking for information in familiar places. The problem is not all cues can be found in the same place in a foreign
language, this is where a teacher is needed to point out new cues and help them understand any unfamiliar ones.

The common way teachers divide up a foreign language is into the four skills:
- Listening
- Speaking
- Reading
- Writing

The separation of the individual language skills is a lot more explicit than with a child’s native language.

This way of teaching the four individual skills is inappropriate for teaching children, as children will be far more proficient in using the spoken language than reading or writing it. Therefore it is far more suitable for spoken language to be the principal source of foreign language learning, and to introduce the other skills subsequently.

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**Figure 2.2 – Foreign Language Learning Structure**

Figure 2.2 is an example structure for child foreign language learning. This places an emphasis on the oral skills of the learning process. As a primary school teacher will not necessarily be experienced in teaching foreign language as it is a new part of the curriculum at Key Stage 2 they may have difficulty in speaking the language correctly. This is where a computer-based tutor can be used to expose the child to the way in which a native would speak the language and help them in developing their accent, pronunciation and intonation of the language.

**Child-Centred Learning**

When learning a new language children are generally more enthusiastic and more willing than adults to play an active part in language lessons due to their lower affective filters. They are more concerned about trying to please the teacher, than their peers, as secondary school pupils tend to be. Children do struggle with self-motivation though and are more likely to lose interest in the lesson than adults. This is partly due to the fact they struggle to actually talk about the language itself and any concepts they find difficult to understand such as grammar.
As there are such significant differences between adult and child learning processes, when teaching children taking a child-centred approach can be more beneficial to the child. Child-centred learning, as described by Wyse and Jones (2001), involves the following:

- Building on the child’s interests. This would mean teaching topics the child can relate to such as hobbies, as a child would be motivated by being able to talk about what they enjoy doing.
- Involving the child in the planning of the work. This allows the child to feel part of the teaching process and gives them some element of control over what they would like to learn.
- Reacting spontaneously to issues of interest. Children are rarely ever predictable in the way they react to situations, so it is important lesson plans are flexible. If a particular aspect of the language really excites a child, it should be possible for them to be able to explore it further.
- Offering choices. No child particularly likes being told what to do, and forcing a child to learn something they are not interested in can sometimes have the opposite effect. If the child appears to have some element of choice, they are more likely to be willing to learn about it.
- Engaging in discussion. Children are not passive learners, they like to be able to get involved and this interaction is an important part of language learning as it allows the child to practice their language skills whilst also providing feedback.
- Encouraging independent learning strategies. This is particularly important in a classroom environment as all children learn at a different pace, and there is not necessarily the one-on-one support available for this. A computer-based tutor is a great support tool for independent learning, as it can be tailored to use language at the level of the child user and also provides feedback on their learning progress. Although this is only possible if the tutor is adaptive, intelligent or configured in such a way by the teacher, parent or child.

Language and learning can actually be seen as interdependent, as language leads to learning which in turn increases the power of an individual’s language resources. Modern Foreign Languages is unlike other subjects, as children will have had previous experience in learning their native language. Therefore they may already have all the tools necessary for learning a foreign language and if the critical period hypothesis is to be believed are in a better position than adults to acquire a second language successfully. Although parts of a child’s previous language learning experience can be applied to second language acquisition it is important to have the guidance within a classroom environment to point out the differences between the child’s native language and the new language.

As Modern Foreign Languages is a new subject to the Key Stage 2 curriculum in most schools, teachers will need to schedule it into an already demanding lesson schedule. One of the most important aspects of language learning is the opportunity to practice language skills, but this is not always possible for each individual child as part of a large class. Computer-based tutors offer a solution for language learning due to the independent learning opportunities they offer, each child can practice their language skills and receive feedback.

The way in which computer-based tutors can be used to support child language learners which be investigated in the following section.

### 2.4 Computer-Assisted Learning

ICT is becoming an increasingly important part of the national curriculum. In 2003 the government published a review entitled ‘The big pICTure’ of which the major findings included:

- Higher ICT usage normally resulting in higher achievement levels.
- Better quality ICT resources generally associated with higher school standards.
- Using ICT tended to motivate the children.

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With all these potential benefits that ICT can provide and the reality that ICT skills are becoming more and more essential in the workplace, the government are keen for schools to ensure ICT is fully incorporated into the existing curriculum. A strategy has been developed to support schools in this process, offering funding for training and equipment, online resources and teaching materials.

TeacherNet, a government managed website for teachers, provides a number of relevant facts about current ICT usage in primary schools:

There is an average of 37 computers per school, approximately 1 computer for every 6.2 pupils.
- 99% have interactive whiteboards.
- 91% have a network in place.
- 99% are connected to the Internet.
- 78% have a broadband connection.
- 85% of teachers are reported to be very confident in using ICT in their job.

One way of incorporating ICT into the curriculum is Computer-Assisted Learning, which can involve the use of computer-based tutors. This allows a child to acquire ICT skills whilst building on their knowledge of another subject, therefore supporting cross-curriculum learning. With the majority of primary schools in possession of appropriate equipment and skills to support this style of learning, it appears to be a good solution to allow the schools to meet the current government targets for both ICT and Modern Foreign Languages at Key Stage 2.

### 2.4.1 Computer-based Tutors

There are many benefits to using computers as tutors within education, these benefits, as stated by Bennett (1999), include:

- **Flexibility** – the computer-based tutor can be set at different levels depending on the child’s ability. If the child is having trouble with a particular section they can review or repeat that section as many times as necessary. The tutor can also make the lessons more stimulating and interesting to keep the child motivated and enhance their learning.

- **Using established techniques** – the computer-based tutor can incorporate existing techniques employed by teachers, and also combine a number of techniques from different teachers enabling children to benefit from the skills and experience of other teachers, rather than just their own.

- **Going beyond teachers’ ordinary skills** – if a child cannot understand a particular teaching method, the tutor can adopt an alternative approach.

- **Enhancing other teaching aids** – a computer-based tutor can be easily updated, via the Internet for instance, in contrast to textbooks, which need to be replaced entirely every few years when the material becomes out-of-date.

When introducing computer-based tutors into schools it is important to consider the possibility of the objections that may arise from other stakeholders, such as the class teachers or parents, questioning the overall benefit to the child. These may include:

- **Computers crashing or software having bugs, leaving the child with nothing to do** – this is a rare occurrence as technology is continually improving and software currently on the market should have been through thorough test procedures. If it does happen and the problem cannot be instantly sorted it is always possible to go back to traditional teaching methods.

- **Computers not being able to make the same judgements as a human** – it is not necessary for the computer to be able to make the same judgements as a human since the teacher will still have the power to make the important decisions such as setting the tutor at the correct level for the child.

- **The school not having enough funding** – funding is available from the government for schools to enable all pupils to have some level of ICT exposure.
Computers cannot give necessary and meaningful personal attention to individual children – if deemed necessary the computer will be able to give instant feedback to children such as whether they have achieved the correct answer, which may be more than they receive within a class of 30 other pupils.

Some children may not have the necessary ICT skills to gain any benefit from the tutor – interfaces should be designed in such a way that it is easy and simple for any child to use, and in using the tutor the child would gradually develop and improve on their general ICT skills.

These objections will be discussed specifically in relation to the computer-based tutor in the requirements sections.

All possible objections about computer-assisted learning are easily solved providing the correct strategy is employed when introducing computer-based tutoring into the current learning environment. It is important that the tutor’s usage is carefully considered to ensure maximum benefit to the child; this includes taking into account the age of the user when designing the software.

Teachers themselves may not be familiar with computer-assisted learning, although from the statistics quoted previously it seems that the majority of primary school teachers are comfortable with the use of ICT generally. When establishing computer-based tutoring as part of the curriculum teachers will also need to consider:

- Setting the tutor at the correct level for each individual child.
- Matching the content of the tutor to the planned material to be covered within the classroom lessons.
- Scheduling computer time, as the school will not necessarily have enough computers for all pupils to use at one time.
- Monitoring use, as the teacher will not be directly teaching it is important that pupils are supervised to ensure they do not get distracted from their task.
- Providing assistance, there can often be technical problems with computers and teachers which will need to know how to deal with or where to go for help.

The tutor should be designed in such a way that it supports the teacher in their task as much as possible, since the teacher is a key stakeholder in the system and can affect the overall success of the tutor. Although the previous points will not be addressed in relation to the computer-based tutor and will be left to the discretion of the teacher as they are out of the scope of this project.

Computer-based tutors may not be suitable for all curriculum subjects, but one subject that it would benefit is that of Modern Foreign Languages. As MFL is a relatively new subject within the Key Stage 2 curriculum incorporating computer-based tutoring from the beginning would limit the amount of adaptation needed for lessons to the new learning tool.

2.4.2 Tutors for Modern Foreign Languages

Computer-based tutors have been used for a number of years to aid language learning. Initial studies of this style of learning, as stated by Chambers et al (2004) have found that it often results in:

- Increased rates of vocabulary acquisition.
- Improved grammatical accuracy.
- Higher language grades.

The benefits of computer-based tutors have been well documented, but now a new approach is needed to the way in which the tutoring software presents the material. This is particularly true in the case of primary schools as the introduction of Modern Foreign Languages into the Key Stage 2 curriculum requires child users to be considered when designing the system.
Almost all early tutoring systems were based on the behaviourist model of learning. This was a single methodology, which involved the imitation of correct utterances using headphones and a microphone. This methodology incorporated a number of different techniques to aid learning such as gap filling, text reconstruction and multiple-choice questions.

It has since been found that learners are actually able to create utterances that had not previously been presented to them, which highlighted a fundamental flaw in this tutor design; it didn’t take into account the user’s ability to be creative. This therefore supports the case for looking at new ways to construct computer-based tutor systems.

Baddeley (1983; cited by Chambers et al, 2004) proposed that effective memory appears to be achieved by following logical ‘memory link paths’. If a computer-based tutor is designed in such a way that using it strengthens these logical paths this will aid better memory recall and therefore enable better learning. Unlike the behavioural model this approach recognises the importance of the ‘human model’ as the way in which learning takes place subconsciously and the computer-based tutor should be designed to support this existing way of learning. This is basically the assumption that the deeper and stronger the trace the easier it is to remember.

One way of achieving this goal is for the computer-based tutor to use a ‘learner-centred’ approach. This will maximum the learning potential in any given situation. Hutchinson and Waters (1987; cited by Chambers et al, 2004) argue that if an image gets into the brain through a number of different pathways – by hearing, reading, writing and speaking – that image is likely to be a richer image than if it gets in through only one pathway. The image will thereby be much stronger and much more easily accessible, since it will have more connections into the network. This contrasts with previous theory as it is saying that it is actually better to have multiple paths to the same thing, therefore the use of other skills can make the entire learning process more effective. This means that in designing the computer-based tutor the language skills needn’t be completely separated into listening, reading, writing and speaking, but rather combined in such a way that allows the child to develop two or more skills simultaneously. For instance, developing both listening and reading skills by having the text on screen whilst being spoken aloud. This also enables the different skills to be practised in various ways and consequently increasing the chance of the skills being acquired by the child.

The main advantage computer-based tutors offer is their ability to act as individual tutors. Aristotle, the ancient Greek philosopher and tutor to Alexander the Great, once said: “For what is the best choice, for each individual is the highest it is possible for him to achieve.”

Today children have access, via a computer, to a private tutor that is even more knowledgeable than Aristotle himself, enabling each child to reach their own individual learning potential.

Computer-based tutors can give children the chance to repeat sections they are struggling with. This ensures no child falls behind with their learning, as once a child gets behind within a traditional classroom-based learning environment; they may never be able to catch up to their peers. It will also offer the child the option to request extra help, which they may be too embarrassed or confused to ask for in class. Additionally, the tutor helps brighter students reach their intellectual limits by providing them with additional work that may overwhelm the poorer students if presented within a classroom environment. Essentially a computer-based tutor doesn’t require a child to fit into a set ‘mould’ based on the ability of the average pupil within the class.

A major consideration when designing any software program is the design of the interface. This is particularly important when designing an educational tool for children; as if the child has trouble interacting with the system then their learning will be inhibited. This topic will be explored in more detail in the following section.
2.5 Human-Computer Interaction

Human computer interaction is the study of how humans and computers interact with each other; this takes place through the user interface. As this is the main point of contact and the means of control for the human in interacting with the computer it is important to design the user interface in an informed manner, this involves a process called interaction design.

Interaction design is about designing interactive products, in particular investigating ways to enhance and expand the way in which people work, play, communicate and interact in their daily lives.

The main activities involved in the interaction design process are identifying the users needs, and subsequently deriving the requirements for the interface. The next stage involves iteratively producing alternative designs that match the requirements and building interactive prototypes based on the designs so the intended end users can test them out. A final phase involves evaluating the system throughout the project and iterating through all the activities as necessary.

It is important to involve users throughout the design and development process, and also to consider what usability and user experience goals are going to be adhered to during the project. Consequently, in this section the involvement of stakeholders, user centred design processes and usability goals and principles will be discussed.

2.5.1 Usability Design Goals and Principles

Usability is about optimising the interactions people undertake with interactive products, which can be divided into the following goals as stated in Preece et al (2002) and aid in assessing the acceptability of a system. See the Literature Review Appendix.

User experience goals involves thinking about what the interaction feels like to the user and requires looking at the system design more from the users perspective. The important user experience goals to consider when designing for children can be found in the Literature Review Appendix.

These user experience goals can often have trade-offs with the usability goals; as for instance something that is entertaining could be less efficient. In a system aimed at children entertainment is of greater importance than in some other systems, so it is feasible that some of the efficiency could be sacrificed in favour of entertainment.

Usability principles are another form of usability guidance; they differ slightly from the usability goals because they tend to be more prescriptive. In addition they are used as a basis for evaluating prototypes, rather than for informing a design. Usability principles are often referred to as ‘heuristics’, which involves selecting an appropriate solution using a set of rules. There are 10 main usability principles as stated by Nielson et al (2001), which can be found in the Literature Review Appendix.

2.5.2 Cognition & Interface Design

Cognition is the thought processes that takes place in our heads during everyday activities, this is an important consideration when designing an interface as the system should be designed in an intuitive way that reflects the actual thought process for a given task. This enables it to be easily learnt and remembered. As reviewed earlier, a child’s thought process can differ from that of an adult. Research into this conducted by Jean Piaget, a developmental psychologist, found that children lack experience and understand the world differently. Therefore it cannot be assumed that just because an adult carries out a task in one way, a child will go about it in the same way.
The thought process can be broken down into a number of different activities as stated by Preece et al (2001):

1. **Attention** – this involves what we choose to concentrate on at any given point in time from a range of possibilities. The design of the system should attract the attention of the user to the relevant information at each stage of the task using techniques like animation, bold colours and ordering. To make specific interface elements stand out clutter on the screen should be avoided as this also can create confusion.

2. **Perception** – refers to the way in which different sense organs obtain information from the world around us, and how this information is transformed into experiences of objects, events, sounds and tastes (Roth, 1986; cited by Preece et al, 2001). It involves ensuring the user can easily distinguish what icons mean, particularly in the case of children who haven’t had such a vast life experience and may not understand icons that, for instance, refer to the office environment. Sound, which is an important element of a language tutor system, should be audible and understandable.

3. **Memory** – involves using previously gained knowledge to decide how to react to a given situation. It is important not to overload memory because as stated by George Miller (1956; cited by Preece et al, 2001) only 7 chunks of information, plus or minus 2 chunks, can be held in short-term memory at any one time. This is why recognition rather than recall is a useful concept to save users from remembering huge amounts of information.

4. **Learning** – users prefer to learn by doing because this is a lot more interesting than trying to read a manual and it is also easier to apply the concepts directly rather than trying to visualise specific operations in one’s mind. The interface should encourage exploration as this will motivate the user to learn how it works and also guide the user by restricting certain functionality if is not necessary at a given stage in the task.

5. **Reading, Speaking and Listening** – different users have different preferences over the way in which they process languages. Children in particular prefer listening to reading, so speech should be used to in conjunction with large amounts of text to allow the language to be processed in multiple ways. Although it is important to realise that the use of speech is not appropriate in all situations, for instance in a menu system. If a child is required to read specific text on an interface it should be at an appropriate reading level for their age. In a study by Bernard, Mills et al (2001) it was found that children aged 9-11 prefer 14-point font to 12.

6. **Problem-Solving, Planning, Reasoning and Decision-Making** – these include all cognitive processes that involve reflective cognition, such as considering different options and what the consequences of each option may be. These kinds of processes should be limited to only focus on the learning of the foreign language rather than requiring the user to put detailed thought into what interaction to perform next.

As a child’s thought processes are not yet as fully developed as an adult, simplicity is the key factor when designing interfaces for children. Norman (1988) specified seven principles for transforming difficult tasks into simple ones:

1. Use both knowledge of the real world and knowledge in the head.
2. Simplify the structure of tasks.
3. Make things visible.
4. Get the mappings right.
5. Exploit the power of constraints.
6. Design for error.
7. When all else fails, standardize.

The important points here are breaking down tasks into small manageable chunks and providing better guidance on how to carry it out. Making everything visible to the user, if a child can’t see it on the screen they won’t be aware it exists. Also to use constraints to stop the user getting lost or confused with having a vast array of options available to them.
2.5.3 Interaction Styles

There are a number of different interaction styles; the appropriateness of each depends on the use context, the task at hand and the intended users. These interaction styles, as specified in Dix et al (2004), can be found in the Literature Review Appendix.

2.5.4 Interface Structure

When designing the interface of a system the most important consideration is the way in which it will be perceived by the potential end user, as different people may perceive certain interface elements in different ways. Jon May (1997) describes perception as an active process, blending both knowledge and sensation. The structure of the perceived world affects the user’s interactions with it, and the user’s interactions with the world affect our subsequent interpretations of its structure. The user’s perceptions of the real world are often directly transferred to the computer interface, and this needs to be taken into account when decided on how to structure the interface. At the same time it is important to note that a child’s perception of the real world will differ significantly to that of an adult.

The way in which a display is structured will constrain the way users can navigate through it, as it can be perceived on many different levels from an overall view down through many levels of detail. At any given moment the user can only perceive objects at a certain level, therefore a well-composed display should allow the user to focus on the object that they require easily.

Grouping

Grouping is an important aspect of the interface structure, as this allows for easier interaction for the user. Grouping together elements visually allows users to find a particular type of group that they need to use and also helps give an overall idea of the group’s functionality. This helps children, who often have little experience of using interfaces, to learn more quickly. Grouping of interface elements can be done in a number of ways for instance an example of type would be grouping all the icons together that allow the user to navigate around the interface.

There are a number of ways in which grouping can be achieved within an interface, which include:

- Explicit grouping using shapes such as boxes to surround particular elements.
- The appearance of the elements, for instance all elements that are of the same colour appear to be grouped together.
- Spatial arrangements, such as putting all the elements in a close proximity or even collocating them, if this is appropriate.

Grouping cannot be avoided, as even if it has not been explicitly designed into the interface, users will still perceive some kind of group and if this wasn’t intended it could cause confusion.

Although grouping together similar elements helps a user locate a specific group of functions, once they have located the group it is useful if they are able to pick out the particular interface element they require. A number of methods can be used to achieve this:

- **Highlighting** – this can be attained by grouping together elements by proximity but making one stand out by using a different colour. Highlighting can be used to give the user feedback on a particular selection they have made and also to ensure the user is focussed on the part of the interface they have activated, especially as a child user may be distracted quite easily.
- **Greying Out** – this is when specific interface elements are fainter than others in the group to indicate their unavailability and so the user is less likely to try and act upon them.

The form the icon elements of the group also needs to be considered.
Icons

Icons are designed to represent a particular function that the system will perform when clicked on. They can take the form of a complex pictorial representation of a function, normally similar to real world objects, or a more simple abstract shape. There are advantages and disadvantages to using each, complex pictorial icons often make it easier for a user to understand the function it will perform if they have never come across it before, particularly in the case of children who may struggle with understanding abstract concepts and will be more comfortable with pictures that they recognise. Although once abstract icons have been learnt they are often easier to pick out from a group of interface elements. Positioning icons in the same place will allow the user to remember their rough location, so they know where to start looking for a particular icon.

Interface elements that perform similar functions, and are therefore grouped together, can either use different icon representations or the similar ones with different text labels. If a user knows what a particular icon looks like, the fact it is dissimilar to other icons in the group will make it easier to pick out, but if the user doesn’t know what the icon looks like and has to read the text labels they may find it difficult to separate the labels from the ‘background’ of the icons. Making individual icons similar can solve this problem, so the user still perceives them as a group, but allowing the text labels to stand out more. When designing for child users their limited understanding of the written language needs to be taken into account, as certain labelling may be unfamiliar or confuse them more than a pictorial icon would.

There is a trade-off when designing an array of icons that users will have to search frequently, as making the icons significantly different will allow the user to pick out the functionality they require, but as the icons will all look different the actual array may be difficult to pick out. This is where using techniques such as explicit grouping will help the actual group become more obvious to the user.

One of the main functions of icons is to allow the user to navigate through a task, and therefore it is essential all icons relating to navigation be grouped together, and in the same position on the interface to ease navigation between screens.

Task Navigation

Navigating through a task will be something carried out frequently when using a computer-based tutoring system. Therefore it is important that the transitions between stages of the task are as smooth as possible to stop the task being disrupted. This is particularly true in the case of children as any distraction from the task at hand can cause severe disruption to the learning process.

Grouping is a huge part of task navigation as having to move attention between groups makes navigating through an interface much harder. There should be as few transitions between groups as is possible and the grouping of interface elements should correspond to the task the user is performing, as this will actually determine the way in which they actually carry out a task. This makes it both aesthetically pleasing and will help support the task.

Transitions between stages in a task can often be ambiguous, and the more ambiguous a transition is the more difficultly the user will have in making the correct decision. Children will have particular trouble with this, so the ambiguity of a task should be as limited as possible and they should be offered support to make a decision at each step. One way of aiding this process is to give different tasks a common structure that can then be learnt and therefore making new tasks quicker to comprehend.

Grouping, icons and task navigation all add to the look and ease of use of an interface, but it is also essential that the interface have an appropriate appearance, which is that of a teaching tool. It should be aesthetically pleasing to increase the users’ satisfaction and productivity, but not include any complex
decoration that could be distracting to the user. Colour and 3D can be extremely useful in reinforcing specific elements but should be used sparingly to avoid distraction or making text difficult to read.

The main aim for a computer-based tutor is an educational one; therefore it is important to consider how the design of the interface can maximise the learning benefit for the child. This will be explored in the following section.

### 2.5.5 Educational Design Principles

Najjar (1998) has developed a number of principles of educational multimedia for user interface design which can be found in the Literature Review Appendix.

These principles cover important factors with regard to the educational aspect of the computer-based tutor, although the target user group for the educational software also needs to be taken into consideration specifically as designing interfaces for children and adults differs tremendously. It is important to get feedback and input from the actual intended end users, who in this case are children, on the way in which they prefer to interact with the interface itself.

### 2.5.6 Child-Centred Design

There is a limited amount of literature on actually designing interfaces explicitly for children and therefore designers often just apply their own perceptions and preconceived ideas about education to generate the requirements of the child user.

There has however been a number of design principles developed by Chiasson and Gutwin (2005) specifically relating to interfaces for child users and these divide into three major areas of development, which include cognitive, physical and social/emotional. These areas have then been divided into the various ways a child will develop in each specific area:

#### Cognitive Development

**Literacy:**

1. *Interfaces should be strongly visual, avoiding text as much as possible and reducing cognitive load* – children may not yet completely understand text-based instructions and so the tutor should keep these to a minimum. Another important consideration is that children tend to be creative or more often phonetic spellers, and therefore expecting more than a few words of natural language input could cause confusion between the child and the computer-based tutor.

2. *Content-specific metaphors are useful in helping children navigate interfaces* – if the child is familiar with the structure of the interface, such as that of a storybook then they will find it easier and quicker to learn how to navigate.

3. *Instructions should be presented in an age-appropriate format* – the tutor should only use words that the target age group would be able to understand. This may also include the option of having the instructions read aloud as children can understand more spoken than written language.

4. *Instructions should be easy to comprehend and remember* – unfamiliar concepts should be avoided, particularly abstract ones that children at the concrete operational stage will not yet be able to grasp. Using on-screen characters or personas could also help direct the child’s attention to important information and aid their understanding by providing further explanation.
Feedback and Guidance:

1. *Children are impatient and need immediate feedback showing that their action has had some effect, otherwise they will repeat the action until some outcome is perceived* – this is a good illustration of why the design principles produced for adults cannot just be directly applied to children; as adults may find constant feedback annoying, but children often expect it.

2. *Interfaces should provide scaffolding and guidance to help children remember how to accomplish tasks* – the tutor should use these techniques to support the child through each individual step of a task, to stop them feeling lost or confused.

3. *Icons should be visually meaningful to children* – this allows the interface to be intuitive for the child and helps them learn how to use it more quickly.

4. *The interface should provide indication of the current state of the system, whether it is busy processing or waiting for input from the user* – the child may not be able to keep track of the system state or may get distracted from their task, so it is important the tutor uses an easy to understand method of providing this information for instance audio feedback such as toe-tapping or humming.

5. *Interfaces should track and display children’s exploration of environments if it is important for them to remember where they have previously visited* – children are not able to remember the same amount of information as adults, and also tend to explore the interface in a non-systematic way so would not necessarily use it in the same way each time.

Mental Development:

1. *Children’s interfaces need to take into account the fact that children may not yet understand abstract concepts* – this is particularly true for the computer-based tutor as it will be aimed at those children at the concrete operational stage of development and most will not have yet grasped abstract concepts.

2. *Children’s interfaces should not make use of extensive menus and sub-menus as children may not yet have the ability to categorize or have the content knowledge required to navigate efficiently* – children often navigate the interface by using trial and error, until they find the option they are looking for. This can often mean they will not explore the menu system very deeply and therefore not come across any of the advanced options.

3. *Children are accustomed to direct manipulation interfaces, their actions should map directly to the actions on the screen* – children will learn the laws of cause and effect early on, therefore will expect that when they perform an action for something to happen.

Physical Development

Motor Skills:

1. *Make mouse interactions as simple as possible. One-click interfaces are easier than dragging or double-clicking* – a child’s fine motor skills may not yet be fully developed so the physical interaction with the interface must be considered, making it as easy to use as possible. This also includes ensuring the child is not required to hold down the mouse button for extended periods of time as this is something else they may struggle with.

Tangibility:

2. *Direct manipulatives allow children to explore and actively participate in the discovery process* – this will motivate the child to learn as it will keep them interested in the tutor and the learning process.
Motivation and Engagement:

1. *Technologies should give children the ability to define their experiences and be in control of the interactions* – this enables the child to learn about the consequences of their actions in a safe environment as the actions the child can actually perform is limited to the context of the task.

2. *Animated pedagogical agents are useful for learning environments; even those who do not provide any advice or interaction are perceived positively* – these agents can guide, encourage and entertain the child, although it is important they are supportive rather than distractive.

3. *Activities should be inherently interesting and challenging so children will want to do them for their own sake* – these activities could be solving a problem or learning a new skill, basically a task that has a clear and easily comprehensible goal.

4. *Supportive reward structures that take into account children’s developmental level and context of use help keep children engaged* – these rewards could include multimedia messages, scoring systems for games or bonus activities when a task has been completed correctly.

Although all these principles have been designed specifically with children in mind, it is still important to involve children directly because these principles are quite broad and every system is different. Children are sometimes involved at the testing stage after a prototype has been developed but to exploit the maximum learning potential an interactive system offers, the potential child users should be involved right from the design stage as they are the key stakeholders in the system along with the class teacher.

Children today have grown up with these interactive technologies so have high expectations of the experience the system can offer them. They are using technology outside of school and their opinions based on these previous experiences are extremely useful when designing a new interactive system that they will enjoy using. Rather than applying existing teaching techniques to a computer-based learning tool, the new technologies available to designers should be exploited to their full potential, which will enable new and exciting ways of communicating the teaching material to the user. Children have a natural desire to explore and discover, and an interactive educational system will allow them to do this in their own individual way rather than being constrained in a classroom environment. Therefore the computer-based tutor enables new possibilities, which would not have been previously available to the child.

Essential parts of this process are the child end users, as involving them will enable the designer to develop a fundamental understanding of all aspects of their learning experience. Incorporating the child’s perception of the world, how they communicate and the ways in which they learn through play. Taking into account all these factors will greatly increase the appropriateness of the final design.

Druin (1999) has developed one such design technique in the Human Computer Interaction Lab at the University of Maryland. The process is called Co-operative Inquiry and is divided into 3 stages:

- **Contextual Inquiry** – is where children are observed interacting with current technologies.
- **Participatory Design** – is where ideas are generated by building with household materials.
- **Technology Immersion** – is where children are exposed to technology they might not have had the opportunity to explore yet.

The goals of the research are to observe how children use current technology and determine what types of technology children need. It also involves working with the children to develop technologies that will enable them to be creative, explore, learn, communicate and that are enjoyable. Additionally discovering what they like and what they found difficult or boring. The research also helps to generate an understanding of how adults can assist children to become inventors and designers.

In summary, when involving children in the design process it is important to take into account the particular stage of cognitive development, as they may have difficulty expressing abstract concepts and
actions (Piaget 1971; Piaget 1973). Therefore the way in which their feedback is interpreted must be considered and providing various ways for the child to express their ideas and opinions, such as through drawing or building models, is extremely useful.

2.3 Conclusion

After completing the review of the relevant literature it can be understood there is a requirement for a computer-based tutor to support primary schools in introducing Modern Foreign Languages into the curriculum at Key Stage 2. It is important that the tutor contains appropriate content to meet the specific requirements of the National Language Strategy set out by the government. It should also fit in with the learning styles of children within the Key Stage 2 age group (ages 7-11) at the concrete operational stage of development, and specifically take into account the way in which children acquire a second language in comparison to older learners. Finally it is essential that when designing the user interface children are part of the process, as the design cannot be simply based on previously established design principles in the same way as interfaces designed for adults can.

“Computers for kids need to be fun like a friend, but can make me smart for school. They should also be friendly like my cat. The real thing is that they shouldn’t make me have to type since I don’t like that. I can talk much better!”
(Druin 2002: Researcher Notes, April 3, 1999, Quote from an 8 year-old child)

Children can be extremely honest and insightful in their feedback and responses, and excluding them from the design process can result in an abundance of potentially significant design ideas being lost. The involvement of children will commence in the requirements analysis for the computer-based tutor, which will be incorporated in the following chapter along with requirements based on findings from the literature review and the evaluation of any existing software relating within the project domain.
Chapter 3

Requirements

3.1 Introduction

This chapter will explore the needs of a computer-based language tutor aimed at children and identify the specific requirements for the system. Preece et al (2002) defines a requirement as “a statement about an intended product that specifies what it should do or how it should perform”. It is important that the requirements specification is as clear and unambiguous as possible with regard to the system functionality and performance. This is because requirements can often be interpreted in a different way to what was originally intended, which can cause problems at later stages in the project. The requirements may be frequently subject to change throughout the design process as opportunities arise and therefore it is essential this process is an iterative one.

The requirements will be gathered from a variety of different sources. The literature review provides valuable information, both theoretical and from various case studies, relating to current academic ideas in respect to language acquisition, ICT and human computer interaction. It is also necessary to consider other sources such as the system stakeholders, who will have various needs and wants depending on the level of their involvement with the system. Finally it is important to investigate similar existing systems to find out what is currently available and to learn from previous successes and failures. The requirements analysis will explore each of these sources and the following requirements specification will identify the individual requirements.

The following chapter will analyse in greater depth the various sources the requirements will be gathered from.

3.2 Requirements Analysis

3.3.1 Literature Review

The literature review covered a wide range of material within the problem domain of this project. The material included learning theory, second language acquisition, the national curriculum at Key Stage 2 for MFL, computer-assisted learning techniques and guidelines for human-computer interaction. This research needs to be taken into account when compiling the requirements for the computer-based tutor with regard to the content and functionality of the system.
Those requirements resulting from findings of the literature review can be found in the requirements specification (section 3.3), the origin of each requirement has been clearly identified.

### 3.3.2 Stakeholder Involvement

Stakeholders, as defined by Boddy et al (2005), are the people and groups with an interest in the project, and who can affect the outcome. It is therefore important to gain the support of the key stakeholders in the project to ensure the success of the system. The possibility of conflicting requirements from different stakeholder groups also needs to be taken into account. At the beginning of a project a stakeholder analysis should be carried out, and according to Boddy et al (2005) this involves the following:

- **Identifying stakeholders, interested parties** – in the case of this project the stakeholders are the children who will be using the system, the class teachers, the school language co-ordinator, the Qualifications and Curriculum Authority (QCA) and anyone involved in the design, development and maintenance of the system.

- **Assessing their commitment** – the following table illustrates the anticipated level of commitment needed for the success of the system by each of the stakeholder groups.

<table>
<thead>
<tr>
<th>Key Stakeholder</th>
<th>Vigorous opposition</th>
<th>Some opposition</th>
<th>Indifferent towards it</th>
<th>Will let it happen</th>
<th>Will help it happen</th>
<th>Will make it happen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>X</td>
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<td></td>
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<tr>
<td>Teacher</td>
<td>X</td>
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<tr>
<td>Language Co-ordinator</td>
<td>X</td>
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<td></td>
</tr>
<tr>
<td>QCA</td>
<td>X</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

Table 3.1 – Stakeholder Commitment

- **Assessing their power to help and hinder the project** – each of the stakeholder groups has been rated high or low.
  - Children (high) – if the children don’t want to use a computer-based tutor to learn a language or don’t like and enjoy using the final tutor design the project will have been a failure.
  - Teacher (high) – if the class teacher is resistant to a change in teaching practices or isn’t familiar with technology this will be reflected in their pupils therefore the project is less likely to be a success.
  - Language Co-ordinator (high) – the language co-ordinator needs to be supportive of the project as they have the responsibility of setting the lesson plans that will need to be altered in order to incorporate the computer-based tutor.
  - QCA (low) – the project won’t directly affect QCA. The system needs to simply follow their guidelines, therefore it is not important to have the support of this stakeholder group to ensure the success of the project.
  - Other (high) – those stakeholders involved in the development, design or maintenance of the system are needed for the success of the project as their input essential to ensure the system meets the needs of the other stakeholder groups.

- **Assessing their interests, what they will think and do about the introduction of the new system** – this involves considering each of the stakeholders different goals, what is expected of them in relation to the new system and whether the introduction of the system has a positive or negative effect on them. This has been considered for each stakeholder group:
  - Children – the child’s main goal is to enjoy learning the language therefore the new system needs to facilitate this goal. They are expected to be able to use the tutor and learn from it, so it should be easy for them to use. It should hopefully have a positive effect on them if they enjoy using it and enable them to learn a new language more effectively.
Teacher – the teacher’s main goal is for the system to improve the child’s language skills therefore the tutor needs to be effective in its teaching or in allowing practice if improving their skills is an aim and to cover the appropriate material. The teacher may be expected to demonstrate the system, so it shouldn’t be too difficult for them to be able to use. It should hopefully have a positive effect on them by making their job easier and consolidating what they have taught the child in the classroom.

Language Co-ordinator – the language co-ordinator’s main goal for the system is also to improve the child’s language skills. Nothing will directly be expected of the language co-ordinator in relation to the system, although it should have a positive impact on them, as it will be an additional tool to support their main goal.

QCA – QCA’s main goal for the system would be for it to follow the national curriculum for Modern Foreign Languages. As they would not be directly impacted by the system nothing is expected of them and it also has no effect on them.

Other – the stakeholders involved in the design, development and maintenance of the system do not have a specific goal in relation to the system, as they are not directly involved with it after completion. They are expected to contribute their expertise where appropriate, but the final system will have little effect on them.

Managing relations with them, to gain their support, or contain opposition – it is important to consider the project from the stakeholders’ point of view. There are a number of different approaches that can be used to influence the key stakeholders in a project, which include Life cycle, Emergent, Participative and Political, as specified by Boddy et al (2005). The most suitable approach for this project would be Participative, which Boddy et al (2005) state is most appropriate when users are knowledgeable about the project, do not feel threatened by it and have ideas to contribute. The influencing tactics that can be used include identifying stakeholders, their interests, commitment and power; exchanging ideas, encouraging contributions; presentation and communication; consulting and negotiating; resolving differences and reaching agreement.

In summary it is important to involve the key stakeholders in the project from the start to ensure its success. These include the child users, their teacher and the language co-ordinator. Jotmans Hall Primary School in Benfleet, Essex have agreed to participate in this project, therefore potential stakeholders will be engaged from this school. This will include observing a language lesson and user interaction with existing systems, and interviewing the children, class teacher and language co-ordinator. The children will also be engaged in a participatory design exercise for the new system.

Lesson Observations and Interviews

A language lesson observation was carried out to investigate the existing teaching techniques that were currently being employed to teach languages to the children at Key Stage 2. Interviews were then carried out with a number of children within the class and their teacher to find out their attitudes towards language learning and ICT. The data gathered during these exercises will be used to form the basis for the initial requirements of the computer-based tutor.

French Lesson Observation (24th Nov 2006)

An hour-long French lesson was observed in a year 5 and 6 class (ages 9 to 11) of mixed ability, although the year 6 children are the lesser able within that year group. The children had been learning French for 2 months, and had had no prior exposure to modern foreign languages within the school environment. The amount of time dedicated to languages varies from week to week depending on the demands of other subjects, but the teacher tries to set aside around an hour a week for it. The following was observed:

- Most of the children seem to like the lesson, when the teacher announced they would be doing a French lesson the majority of them cheered.
- She begins by reinforcing previous vocabulary and gets each child to introduce themselves in French. Some children manage to include some extra vocabulary in addition to the basic construction.
The class is asked a number of questions in French and the children have to put their hands up to answer.

The teacher then gets the children to practise what they had just covered with each other to reinforce the material and also to enable them to practise interaction.

When the teacher introduces the main topic for the lesson she ensures the children are aware of the lesson aims (recognising colours and pronunciation).

A number of different teaching aids are used which include an interactive whiteboard and DVD, activity sheets for the children to make their own flash cards, and different coloured cuddly toys to keep the children’s interest.

The teacher uses a number of different techniques to keep the children’s attention, including reprimanding them for bad behaviour, making them reiterate the task they are supposed to be working on and why, directing questions to children who are not paying attention and refusing to continue with the lesson until everyone is quiet.

As the task is coming to an end the teacher goes round the class to help any children who are struggling to finish.

A lot of different activities are used to practise the same vocabulary, so the vocabulary is constantly repeated.

The children enjoy singing songs, they specifically ask to be able to sing a song they have learnt in a previous language lesson and also sing along to songs on the DVD without being asked to by the teacher.

The children are obviously eager to please the teacher, they try to predict what she wants them to do and show her their work once they have finished without being asked.

Interview with Teacher (24th Nov 2006)

The class teacher was also interviewed to find out about the material she covers in lessons and the different techniques she tries to use. She was also asked what she would want a computer-based tutor to be able to do.

Lessons –

She tries to teach languages for an hour a week either in a single lesson or in two half hour slots.

The topics that have been covered so far include Introductions, Greetings, Colours and Names. She tries to follow the basic order of topics used in the DVD.

The lessons are led by the DVD, but also include worksheets, games, conversations and her asking the children questions.

The DVD sets the level of teaching, but the teacher will spend more time on certain topics if she can see the majority of the class are struggling.

The children are not formally tested on their language skills, but the teacher will assess their progress at the end of the year and comment on this in their school report. There is no formal assessment because it is supposed to be fun and she tries to concentrate on activities like playing games.

Children’s abilities/interests –

The children tend to be good at remembering the phrases, but often to struggle with the pronunciation.

If the children produce good work or have been trying particularly hard they are rewarded with team/table points. There is always a ‘table of the week’ and they receive sweets and get to do the good jobs.

If the children are struggling the teacher will often get the brighter children to help them, the tables being mixed ability aid this.
Current ICT usage –
The only software used is the DVD on the interactive whiteboard, which comes with teacher notes. There is also an audio CD, but she is trying not to introduce too much at once.
Each class currently has a weekly slot in the ICT slot although she has only used this once so far this year. She is hoping this will be used more regularly from January.

Future ICT usage –
- She would like the computer-based tutor to be visually pleasing and not to be too wordy.

Interviews with Children (24th Nov 2006)
Four children from the class were asked the same set of questions, which included their likes and dislikes about the current language lesson, their ICT experience and their hobbies. The data gathered has been broken down into the similarities between the children’s answers and the differences.

Similarities –
- One of the children’s main aims for learning a language is to be able to speak the language when they go on holiday abroad.
- Most of the children didn’t dislike any part of the language lessons.
- The children found the tasks that involved pictures and colouring-in to be the easiest.
- Some of the children found it hard to follow the spoken language on the DVD.
- None of the children said they used computers in school, but they all used them at home for homework and playing games. They all used the Internet and they also had experience of software packages such as Microsoft Word and Excel.
- They all liked computers, particularly because of the amount of information a computer allows the children to access and the different things it allows you to do.
- They all thought that the Internet would be a useful tool in language learning and thought that a computer could be used as a translator.
- The children’s hobbies included football, art, fishing, bird watching, playing on games consoles, walking the dog, shopping, playing outside.

Differences –
- One of the children really struggled with the writing tasks.
- One child struggled with getting all the work done in the time given.
- Although the majority of the children could see the benefit of computers for language learning one child said he would still prefer to learn in class.

The current ICT usage across the school was also investigated to find out what resources are available, the children’s current ICT abilities and if ICT has been exploited for language learning in any way.

Interview with Language Co-ordinator (18th Dec 2006)
One class teacher also has the additional role of language co-ordinator and is responsible for developing the lesson plans for the language lessons, which includes specifying the content for the lessons and also ensuring the school is following the National Key Stage 2 framework for languages. The language co-ordinator was asked about the current ICT usage within the school particularly with regard to languages, and also her requirements for a computer-based language tutor.
- Currently not all classrooms contain interactive whiteboards, but will be fitted by next year to enable them to use the DVD.
- The language co-ordinator is keen for classes to play language games, which interactive whiteboards enable the entire class to participate in.
- Every class has one slot per week in the ICT suite, although the classes with no interactive whiteboard have more than this. There are ten computers within the suite, therefore the class has...
to split up with each group allocated an hour of computer time. This can mean that activities can often take two or three weeks to complete.

- The software used is called RM Classmate, which restricts the children’s access to certain aspects of the system.
- The children begin using computers at Key Stage 1 and are used to using programs such as Microsoft Word and Paint, as well as the Internet and CD-ROMs.
- The teacher should set aside around an hour a week for language learning, although this doesn’t necessarily need to all actually be in the foreign language and can be made up in literacy lessons.
- The language co-ordinator would want the computer-based tutor to constantly repeat the vocabulary of the language to enable the children to practise what they have been taught in class.
- The Key Stage 2 framework for languages doesn’t actually specify what the children need to be taught; it simply states they need to be able to communicate in a foreign language. The tutor should therefore include just the basic vocabulary as set out by the language co-ordinator.
- The children respond best to characters, the language co-ordinator uses puppets with Spanish names to help teach the children Spanish. This technique could be adapted to an animated character for the computer-based tutor.
- The children’s hobbies included football cards, pop stars, swimming, football, gymnastics, dancing, cycling, computer games and horse riding.

In this section the most important stakeholder groups have been identified, which include the class teacher, the children and the language co-ordinator. Their views on current practices have been investigated, it seems that the introduction of language learning into the Key Stage 2 curriculum has been a success as the children seem to be enjoying the lessons and have a real motivation to learn a foreign language. As the teachers have little or no experience in teaching languages there is a vast scope for developing the structure and content of the lessons, which could include the introduction of ICT to help consolidate and practice the material that has been covered in class. The next chapter will explore the software that is currently available for this purpose.

### 3.3.3 Existing Software Evaluation

To help gain a better understanding of the system requirements two existing systems for teaching languages for children at Key Stage 2 will be evaluated. The two systems that have been chosen are Petit Pont by Eclipse Books and Early Start Languages, which supports the material currently being taught at Jotmans Hall Primary School. A number of different evaluation techniques will be employed and include:

- Observing pupils at the school using the two systems and finding out their thoughts and opinions on the systems.
- Assessing each system against an evaluation checklist designed for Computer Aided Language Learning (CALL) systems.
- Performing a heuristic evaluation of both systems with the assistance of a HCI expert.

The findings from each of these will then be translated into requirements for the new system.

### Primary User Evaluation

Two pupils at Jotmans Hall Primary School both aged 10 years old were observed whilst using the Petit Pont and Early Start languages software packages. Screenshots of both software systems can be found in the Requirements Appendix. They were then asked a series of questions to find out their views on each system and which one they preferred.
Petit Pont –

Good points:
- They understood the initial instructions in French.
- They knew how to navigate to the first activity using the navigational tools, which were in English.
- They were able to read the French names.
- They discussed the task aloud together.
- The more they repeated an activity the better they got at achieving the right answer.
- They didn’t understand all the vocabulary but would keep trying until they got the right answer.
- They were able to figure out some of the French instructions even though they had never come across the vocabulary before.
- They were always willing to give an activity a go even if they didn’t understand the vocabulary and often managed to figure it out using their knowledge of English.

Bad points:
- They struggled to understand the instructions in French for the second activity.
- When they didn’t understand the instructions of a task they would click the mouse a lot to see what happened.
- They understood the typing task but found it very hard to remember how to spell the words in French.
- On the sixth task they couldn’t undo a wrong action, so got the task wrong even though they knew the right answer, which was quite frustrating for them.
- They understood the concept of drag and drop, but struggled with the concept of forming simple conversations.
- They were very impatient if anything didn’t load instantly and kept clicking the mouse to see if that would do anything.

User Opinions:
- They thought the system was clever and in particular liked the people in it. They liked the fact it tells you the names of the adults (monsieur/madame) and that it tells you the pronunciation of the words. They found it fun to work out what they needed to do and they liked the fact the pictures would give you a clue to the meanings of the words.
- They didn’t like the fact that some of the vocabulary was hard to understand and that there was no English translation available. They would have also preferred it if the functionality of the system allowed pronunciation to be split up and written phonetically to help them learn how to say it.
- They generally found all of the system easy to use.
- They found the oral activity involving a conversation hard, particularly the pauses and knowing when to speak, as well as understanding some of the vocabulary and the French accent.
- To make the system better they thought there should be different levels of difficulty to make it a bit easier to start with, also to break down some of the words to help with pronunciation. There should also be the option to tell you what the word means in English when you click on it.
- They thought the system helped them learn a bit of French; they managed to learn some of the words that were similar to English. They preferred it to the video because they found the music distracting and it also had clearer pronunciation.

Early Start –

Good Points:
- For the magician game they understood what to do straightaway and where to click.
They understood the bingo game straightaway; they found it easy to play and repeated the game because they enjoyed it.

They understood the quiz and knew how to answer the questions, but weren’t able to answer all of the questions correctly.

**Bad Points:**

- They read through all of the instructions in English first of all. Although they still didn’t manage to initially grasp how to use the navigational arrows, but soon picked it up.
- The problem with the magician game was with the presentation and representation because the colours weren’t all that clear.
- For the shooting game they didn’t even understand the instructions in English, they didn’t like the activity and moved on as soon as they could due to the poor usability and the instructions being hard to parse.
- The problem with the bingo game was some of the colours were hard to identify, which creates poor usability.
- For the dictionary task it wasn’t immediately obvious how to change the order of the words, they tried to drag the words first of all before clicking on the arrows.
- They found the arrows quite frustrating and hard to use, which again is poor usability, but they managed to get the hang of it after a while.

**User Opinions:**

- They liked that the system was easier to use than Petit Pont; this was because the stages were more defined, getting gradually harder as it went through.
- They found the quiz a bit hard when they had to work out what the boy was saying in French, they thought some of the language was a bit advanced.
- They found the task where they had to put the words in alphabetical order easy, as they didn’t actually need to understand the French words to get it right.
- They didn’t find anything hard to use.
- To make it better they would want more games, as some of the activities were a bit boring. They did enjoy the magician and bingo games, but the colours could have been clearer.
- They thought it helped them learn more French.

They both preferred using the Early Start system to Petit Pont. They also said that if the system had a character to guide them through they would want a typical French person (striped top, beret, garlic etc.) or something that fitted in with the theme of the system, for instance a dragon during the medieval game in Petit Pont. The character would be able to translate words for them or give them additional help.

The primary user evaluation provided valuable insights into what existing systems have got right and wrong in terms of the users requirements and generated ideas about changes and improvements that can be made for this system. It is important to evaluate the software using a number of different methods, in the next section an existing evaluation checklist for evaluating Computer-Aided Language Learning will be used. The results of which can be found in the Requirements Appendix.

**Expert Evaluation**

A cognitive walkthrough was carried out on both the Early Start and Petit Pont systems, with the help of a HCI PhD student, to investigate potential usability issues in the existing software and to provide an insight into what works and what doesn’t with regard to a computer-based language tutor. Faulkner (2000) defines this as an expert evaluation method that requires the expert to go through a task, or tasks, with the view of imitating user performance and endeavouring to discover what problems the user might encounter at each stage. In this instance the HCI expert imitated a child’s behaviour when using each system whilst
commenting aloud on all the potential HCI issues she came across during the walkthrough. It is necessary for the HCI expert to imitate the behaviour of the child rather than getting a child to use the system as every child will use it in a slightly different way and the expert will be able to cover more possible scenarios than a single child would.

The results of the evaluation are summarised below for each of the main areas of usability which include:

- **Help & Documentation** - This involves looking at the help that is provided to support the user when using the system, which could be in the form of a separate help system, or instructions and tool tips on the screen. A good help system is essential in enabling the user to use functionality that is slightly more complex and therefore not immediately intuitive.

- **Input/Output** - This involves looking at the way in which the user is required to interact with the system and the feedback they receive from those interactions. It is essential for a user’s actions to have some kind of feedback, as they will transpose their real world expectations about cause and effect onto the system, particularly in the case of children. Feedback is important to enable the user to understand if they have done something right or wrong and to enable progression.

- **Navigation** – This involves the way in which the user moves around the system and how easy this process is. The navigation of the system should be intuitive as getting from screen to screen is not the users primary task and therefore shouldn’t distract them from the task they are trying to accomplish.

- **Presentation** – This is the overall look of the system; it should be appealing to the user but not distracting. It is essential the presentation of the system is consistent and supports the user to carry out their tasks in the most efficient way.

- **User Control** – This involves the amount of control the user has over the system, the method of control and the amount of flexibility they have in this. It is important to get a balance between constraining the user to only carry out appropriate actions and allowing them the freedom to interact with the system in their preferred way.

**Early Start**
The unit about Colours was selected to test during the evaluation. Screen shots of the system can be found in the Requirements Appendix.

**Help & Documentation**

- The help system at the start is good; it pops up to draw the users attention to it. There is no way of turning it off though, so it could become annoying once the user is familiar with the system.

- There is also a good explanation of how to use the navigational arrows once you begin one of the units. This explanation isn’t available if you start by using some of the other system features not contained within a unit though, so the navigational arrows could be initially confusing, as they are not pointing in an intuitive direction.

- The information at the beginning of the unit stating the unit goal is good as it makes it clear to the user what they are supposed to achieve.

- The tool tips that appear when you hover over the navigational arrows are good, although incorrect in relation to the arrows on the first page of the unit.

**Input/Output**

- There is no distinction in tone between the audio feedback for the user getting a question wrong and the user getting the question right. This could cause the user to become confused about the outcome of the activity if they don’t understand the vocabulary.

- There is no visual feedback on some activities as to whether the user has got the answer right or wrong except for the score or if there was feedback it was late and didn’t always correspond to the outcome. This could add to the user’s confusion about the outcome of the activity, as they may not have been keeping track of the current score.
The activities often had no goal, you could have as many goes as you wanted until you got the right answer and the score would never reset. This does not motivate the user to succeed at the activity and doesn’t help with their educational progress.

In some activities no distinction was made between not answering and the correct answer being false, therefore the user could get the right answer without even doing anything. This causes confusion for the user and doesn’t help with their motivation to actually participate in the activity.

The audio was often hard to follow and wasn’t consistent. This could make it hard for the user to follow and understand.

There were often no rewards at the end of activities and in one activity a reward was offered but it wouldn’t allow you to continue playing to be able to win it. This doesn’t encourage the user to complete the activity successfully and can have an impact on their overall motivation to learn from the software.

**Navigation**

- Some of the navigational arrows aren’t particularly meaningful and it doesn’t say what they do so this could be confusing for the user.
- There is no visibility of position within the unit and there is no unit number displayed so it is hard for the user to track their progress through the unit.
- It is good that is has the English telling the user to go to the next activity, which makes it explicitly clear to them.
- The back button only allows the user to go back to the previous activity/video rather than the previous step, which could be quite frustrating for the user.
- The user isn’t aware of when they are on the last activity of the unit, so could be surprised when they end up back at the main menu.
- The confirmation button to allow the user to exit the system is not consistent with the rest of the navigational elements in the system.

**Presentation**

- Some of the fonts are a bit plain and not playful enough for a system aimed at children.
- The overall design is good, quite playful with a good title and consistent look.
- A PDF icon is used which children might not understand.
- The main menu is the wrong shape, the box displaying the unit name gives you the impression it is click-able. This makes the navigation unintuitive for the user and may be confusing.
- There are too many colours used and some of the colour combinations shouldn’t be used in interface design due to the strain they can cause the eyes, it also makes it hard for the user to focus on a particular part of the screen.
- Colours are also used randomly and have no specific meaning that the user can attach to them, for instance using yellow for ‘Oui’ and green for ‘Non’ buttons and can cause confusion for the user. This use of colour is also not consistent throughout the system.
- The interface design doesn’t make a distinction between paper-based and computer-based activities, so the user may be confused as to whether they need to print the activity out or if they can complete it on the computer.
- The title design is not consistent throughout the system, sometimes it is in French or English or both.
- The design of the navigational arrows is also not consistent.
User Control

- The mouse pointer doesn’t differentiate between parts of the screen the user can click on and parts they can’t. It is mainly in the form of a hand giving the impression the screen should be click-able, which could cause confusion.
- A lot of the activities don’t allow the user to replay the audio, so if they miss it the first time they won’t be able to benefit from completing the activity.
- Some of the control buttons for the video aren’t clear and don’t always work in a consistent way depending on whether the video is playing or not, which can make it hard for the user to control.
- Some activities allow the user to answer as many times as they want, continuously adding to the score whether the user gets the answer right the first time or not. This doesn’t provide an incentive for the user to get the correct answer.
- On one activity the audio is too slow to respond after the user has hovered over the colour, therefore it is meaningless and can become annoying.
- There is no undo button in some of the activities which can become quite frustrating as a small mistake can mean the entire activity has to be restarted.

Petit Pont

The unit entitled ‘Bienvenue’ was selected to test during the evaluation. Screen shots of the system can be found in the Requirements Appendix.

Help & Documentation

- The activity instructions often aren’t clear in advance and it is not obvious how to translate them into English if the user doesn’t understand the French vocabulary.
- The help option isn’t always available on all screens if the user gets stuck.
- Some of the activities aren’t explained very clearly and the overall goal isn’t explicitly stated for the user. This means the user may not understand why they are doing certain activities and how it is benefiting their language skills.

Input/Output

- There is good visual feedback for the final score of the activity, but no consistent visibility of the score throughout the activity, which could make it hard for the user to monitor their own progress.
- The audio feedback at the end of each activity is meaningful and clear to the user.
- During the conversation practice it doesn’t recognise if the user registers no audio, therefore they are not encouraged to participate in the activity.
- The user doesn’t know they can receive the rewards until they receive them; therefore they are little use as a motivational tool during the activity.

Navigation

- The unit choice is clear but it is not very clear how to get back to the main menu once the user has navigated away from it.
- The back button isn’t consistently the same throughout the system, which could cause confusion.
- The only way to exit the system is to click on the X in the top right hand corner which isn’t made very clear to the user.
Presentation

- The main menu and unit choice doesn’t stand out from the interface and therefore doesn’t draw the user’s attention.
- The activity number isn’t very clear so it is hard for the user to track their progress through the system and know their current position.
- The overall design is good, it is quite playful and colourful with a good contrast, which will appeal to children.
- The menu shape is strange and the shape of the bubbles in the top left hand corner are inconsistent.
- The unit menu sometimes appears active when it isn’t, which could be confusing for the user.
- The main menu button isn’t consistently in the same place.

User Control

- The mouse pointer changes when the user hovers over something that is click-able, which is good.
- It is not always clear when the user has to click on the text and when they have to click on the image.
- The button to translate the instructions into English isn’t very clear and the user has to hold down the button to keep the text displayed which they could find awkward.
- There is no confirmation message when the user quits an activity, so they could do this accidentally.
- The scrolling mechanism is hard to use and could be frustrating for the user.
- If the user wants to replay the activity they have to go to the previous activity first which could be annoying for the user.
- There is no way of repeating certain information that could be essential to completing an activity; therefore the user loses any benefit they could gain from it.
- During the conversation practice the user has very little control over the pausing the audio and recording their part, which would be frustrating for the user if they were struggling with it.

The Early Start system provided a good help system for the user, but had poor feedback that sometimes sent confusing or inappropriate messages to the user or there was simply not feedback at all. The reward scheme was inconsistent and didn’t motivate the user to want to complete the activity. The navigation of the system was poor, some of the navigation controls were inconsistent and the user had no visibility of their overall position in the system. The overall design of the system was good and suitable for children, although the colour usage was poor as colours weren’t used in a meaningful way and often too many colours were used. The control of the system was quite confusing for the user and wasn’t very flexible with regard to repeating activities.

The Petit Pont system didn’t provide a very good help system and it was unclear how to translate French instructions into English. The overall feedback was good, but the reward scheme doesn’t motivate the user, as they are unaware of the rewards they can receive. The navigation is reasonably clear, but has a few inconsistencies with going back and exiting the system. The overall presentation is good, but a few of the interface elements are unclear and don’t draw the user’s attention. The control of the system could be improved, some controls aren’t clear and hard to use. It could be quite frustrating for the user especially when trying to repeat an activity.

Overall the Petit Pont system was better from a usability perspective than the Early Start system as it was a lot more consistent and less confusing for the user, although there are a lot of improvements that could be made to both systems and will be taken into consideration during the design stage for this system. The findings of the expert evaluation contradict the primary user evaluation where both children preferred the Early Start system. This shows that the presentation of the system is the most important aspect when designing for children, as if it looks appealing they are prepared to put up with other usability issues.
The next section will translate the results of the requirements analysis into a set of requirements for the system.

### 3.3 Requirements Specification

The requirements of a system can be divided up in various different ways depending on the requirement type. Conventionally requirements are identified as functional, what the system should be able to do, and non-functional, the system properties and constraints. As the non-functional requirements can encompass an extremely broad range of different requirement types, Preece et al (2002) divide them into further categories, which include the following:

- **Data requirements** – these capture the type, volatility, size/amount, persistence, accuracy, and value of the amounts of the required data.
- **Environmental requirements** – these refer to the circumstances in which the system will be expected to operate including the physical, social, organizational and technical environments.
- **User requirements** – these capture the characteristics of the intended user group.
- **Usability requirements** – these capture the usability goals and associated measures for the system.

The above categories will be used as a basis to define the requirements for the computer-based tutor.

Preece et al (2002) state that requirements should be made as “specific, unambiguous, and as clear as possible”, this enables the design to more closely match the needs of the various stakeholders in the project and for the fulfilment of each requirement to be measured accurately in the system evaluation. To ensure the requirements for this project meet these criteria the format will be based on the Volere template (Robertson and Robertson, 1999; cited by Preece et al, 2002). The template includes the following fields:

- **Requirement Number** – a unique identification
- **Description** – a brief explanation of the requirement
- **Source** – where the requirement has come from
- **Rationale** – the reasoning behind the inclusion of the requirement

Sommerville (2001) states that a common convention for distinguishing between mandatory and desirable requirements is to use the word ‘shall’ to indicate the former and ‘should’ to indicate the latter. This convention will be employed throughout the requirements specification.

#### 3.3.1 Functional Requirements

1. **Description:** The tutor shall provide tasks that are appropriate for users at the concrete operational stage of development.  
   **Source:** Literature Review 2.2.2, 2.5.6  
   **Rational:** The potential users of the system will be aged 7-11 and therefore at the concrete operational developmental stage as stated by Piaget. If the task assumes the child has an understanding of things like abstract concepts the potential learning outcome from the task will be significantly decreased.

3. **Description:** The tutor should incorporate scaffolding to support the child when carrying out a task, which can be switched on or off depending on ability.  
   **Source:** Literature Review 2.2.2, 2.5.6, Requirements Analysis 3.2.3  
   **Rational:** Bruner discovered that adult mediation in a task encourages the child to become more interested in it as well as simplifying the task by breaking it down for them. The same technique can be incorporated into a computer-based tutor to support the child in their language learning if they require it.
4. **Description:** Each task shall follow a consistent routine.
   **Source:** Literature Review 2.2.2, Requirement Analysis 3.2.3
   **Rational:** Bruner developed the notion of formats and routines, which allow a child to attempt something new in a familiar situation. By designing each task in a similar way the child will quickly understand how to complete a new task, as the format will be familiar to them.

5. **Description:** The content of the tutor shall be at a suitable level for children at Key Stage 2.
   **Source:** Literature Review 2.2.3
   **Rational:** To maximise the potential learning outcome it is important the child is neither bored nor frustrated when using the tutor. Therefore the level of the material presented by the tutor should allow them to be challenged but not become totally lost.

6. **Description:** The system shall reward the user for successfully completing a task.
   **Source:** Literature Review 2.2.4, 2.5.6, Requirements Analysis 3.2.2, 3.2.3
   **Rational:** Providing a reward at the end of a task can increase the child’s motivation to perform the task, which will in turn benefit their overall learning.

7. **Description:** The tutor shall concentrate on developing the child’s listening and speaking skills, providing the option of any written language to be read aloud to the child.
   **Source:** Literary Review 2.3.3, Requirements Analysis 3.2.3
   **Rational:** Children at Key Stage 2 are far more proficient in their spoken language, than reading or writing it. Therefore if they are yet to learn the written word in their native language they will not be able to learn it in a foreign language.

8. **Description:** The tutor should offer the child different options in a task to give them an element of control in what they learn.
   **Source:** Literature Review 2.3.3, 2.5.6
   **Rational:** Wyse and Jones (2001) developed the idea of child-centred learning which includes offering the child choices so they do not feel like they are being told what to do. These choices need to be restricted to ensure the child still covers all the necessary material.

9. **Description:** The tutor shall incorporate various different tasks to consolidate the same material.
    **Source:** Literature Review 2.4.2, Requirements Analysis 3.2.2
    **Rational:** Hutchinson and Waters (1987; cited by Chambers et al, 2004) argued that if an image gets into the brain through a number of different pathways that image is likely to be a richer image than if it gets in through only one pathway. This enables child to repeatedly practice the material they have learnt during their lessons until it is fully understood.

10. **Description:** The tutor shall ensure the user is aware of the goal of each task.
    **Source:** Requirements Analysis 3.2.2, 3.2.3
    **Rational:** If the child knows what the task is trying to help them learn they will be more motivated to achieve this. It will also help keep their learning on the right track.

11. **Description:** New vocabulary shall be supported by images where appropriate.
    **Source:** Literature Review 2.5.5, 2.5.6, Requirements Analysis 3.2.2, 3.2.3
    **Rational:** Children find images easier to process than text as well as looking appealing to them. Najjar (1998) stated that for educational multimedia the medium that best communicates the information should be used, which in this case is a combination of images and text.
12. **Description:** There shall be an option to allow instructions to be translated into English if the child doesn’t understand the task.
   **Source:** Requirements Analysis 3.2.3
   **Rational:** If a child has not come across certain vocabulary before and isn’t able to decipher the meaning of specific instructions then the task will provide no value to them because they will not understand what they are trying to achieve or why they have got the correct/incorrect answer.

13. **Description:** It shall be possible for the user to repeat a task as many times as necessary.
   **Source:** Requirements Analysis 3.2.3
   **Rational:** If a child struggles with a task initially they need the chance to practice to help them understand where they went wrong and to enable them to learn from their mistakes.

### 3.3.2 Non-Functional Requirements

#### Data Requirements

14. **Description:** The tutor shall incorporate the vocabulary as specified by the school’s language co-ordinator.
   **Source:** Requirements Analysis 3.2.2
   **Rational:** The Key Stage 2 framework for languages doesn’t actually specify what the children need to be taught; therefore the language co-ordinator identifies the vocabulary the children need to be taught.

15. **Description:** Information relating to the culture of the country where the foreign language is spoken should be incorporated into the system.
   **Source:** Requirements Analysis 3.2.2
   **Rational:** One of the children’s main motivations for learning a new language is to be able to speak it when they go abroad, therefore providing cultural information will help maintain this motivation.

#### Environmental Requirements

16. **Description:** The system shall be able to be used on a PC.
   **Source:** Requirements Analysis 3.2.2, Literary Review 2.4
   **Rational:** The PC is the most predominant tool currently available in primary schools. The majority of children at Key Stage 2 have had sufficient exposure to using computers both at school and at home to enable them to learn to use the computer-based tutor relatively quickly.

17. **Description:** The system shall be compatible with the hardware and software available at Jotmans Hall Primary School.
   **Source:** Requirements Analysis 3.2.2
   **Rational:** The system is initially intended to be used at Jotmans Hall Primary School; therefore it should work on their existing hardware and software.

18. **Description:** The tasks shall be short and simple in their structure, and also not have any dependencies on completing any other part of the system.
   **Source:** Requirements Analysis 3.2.2
   **Rational:** The children will only have the opportunity to use the tutor for a short period of time once a week at most; therefore it is essential the task structure suits this kind of usage.
User Requirements

19. **Description:** The tutor shall incorporate content relating to children’s hobbies.
   **Source:** Literature Review 2.3.3, Requirements Analysis 3.2.2
   **Rational:** A child is more motivated to learn about something they can relate to and talking about something they enjoy doing.

20. **Description:** Written instructions shall be appropriate for children aged 7 to 11, as well as being simple enough for them to remember.
   **Source:** Literature Review 2.5.6, Requirements Analysis 3.2.2
   **Rational:** It is essential to ensure the child understands the instructions otherwise they will not be able to complete the task.

21. **Description:** The content of the tutor shall incorporate material that the children have previously learnt in class.
    **Source:** Requirements Analysis 3.2.2
    **Rational:** The tutor will enable the children to practise what they have learnt in class, and provide additional help individually, which may not have been available in class.

22. **Description:** The tutor should include an animated pedagogical character to help guide the child through each task.
    **Source:** Literature Review 2.5.6, Requirements Analysis 3.2.2, 3.2.3
    **Rational:** Pedagogical characters can guide, encourage and entertain the child. Children respond best to characters and it helps motivate them in their learning.

23. **Description:** There should be a variety of different tasks to suit different ability levels.
    **Source:** Requirements Analysis 3.2.3
    **Rational:** Children of the same age group differ in ability so not all tasks will be suitable for each individual child. Children also prefer working their way through tasks starting with easy tasks to give them confidence followed by slightly harder tasks to challenge them.

Usability Requirements

24. **Description:** The tutor shall give appropriate, meaningful and instant feedback after a child has completed a task. Any audio feedback shall also be clearly spoken and differ in tone depending on the result of the task.
    **Source:** Literature Review 2.4.1, 2.5.6, Requirements Analysis 3.2.3
    **Rational:** This ensures the child still receives similar personal attention as they would after answering a question in a classroom situation. Receiving feedback will also enable the child to learn from their mistakes.

25. **Description:** The tutor should provide the user with information about the current state of the system.
    **Source:** Literature Review 2.5.6, Requirements Analysis 3.2.3
    **Rational:** Children get easily distracted so may find it hard to follow the actions the system is performing and therefore may not realise if the tutor is waiting for an input from them. They also become frustrated if they are waiting for the system to do something.

26. **Description:** The tasks should be both interesting and challenging.
    **Source:** Literature Review 2.5.6, Requirements Analysis 3.2.3
    **Rational:** Making a task both interesting and challenging will make it intrinsically motivating for the children and therefore greatly benefit their learning.
27. **Description:** The interface design shall be visually pleasing to the user.  
**Source:** Requirements analysis 3.2.2, Literature Review 2.5.1  
**Rational:** The children will be more motivated to use a system that appeals to them visually, as well making them more tolerant of its usability.

28. **Description:** The tutor shall be fun and enjoyable to use.  
**Source:** Literature Review 2.5.1, Requirements Analysis 3.2.3  
**Rational:** Making a task fun and enjoyable helps retain a child’s attention for an extended period of time.

29. **Description:** The computer-based tutor shall meet all of the usability goals as specified by Preece et al (2002).  
**Source:** Literature Review 2.5.1  
**Rational:** These goals have been designed to optimise the interactivity of the system and therefore will make the tutor easier for the children to use.

30. **Description:** The tutor should be designed in such a way the children can match elements of the interface with things they have already come across in the real world.  
**Source:** Literature Review 2.5.1  
**Rational:** This enables a child to learn how to use the system more quickly as they can draw on prior knowledge and experiences.

31. **Description:** It shall be easy for the user recover from a situation they didn’t intend to be in.  
**Source:** Literature Review 2.5.1, Requirements Analysis 3.2.3  
**Rational:** Children are inquisitive by nature; therefore they are likely to click on an interface element just to see what happens and end up going off task. It is important for them to be able to return easily to their task.

32. **Description:** Errors shall be prevented where possible, and if they do occur a simple explanation should be provided.  
**Source:** Literature Review 2.5.1  
**Rational:** As children are inexperienced users that will perform incorrect actions frequently it is important to limit their ability to do this wherever possible. If an error occurs simple language should be used to help them understand what happened and not to cause them distress.

33. **Description:** Important functions shall always be visible to the user.  
**Source:** Literature Review 2.5.1, 2.5.6, Requirements Analysis 3.2.3  
**Rational:** Children will find it hard to look through layers of menus to find specific functions therefore any essential functions need to be easily found on the interface.

34. **Description:** Interface elements that perform similar functions shall be clearly grouped together.  
**Source:** Literature Review 2.5.4  
**Rational:** Users will always perceive some kind of group; therefore to stop incorrect groups being formed in their mind the groups should be clearly defined. This also helps children learn to use the system more quickly as they know which area of the interface to look for a particular type of function.

35. **Description:** All icons shall be simple and not used in an abstract way.  
**Source:** Literature Review 2.5.4, 2.2.2, 2.5.6, Requirements Analysis 3.2.3  
**Rational:** Children won’t have had as much life experience as adults therefore may never have come
across some objects, such as those found in an office, and therefore won’t understand the functions they are supposed to represent. Most children at Key Stage 2 will also not yet be able to understand complex abstract concepts.

36. **Description**: The system shall be easy to navigate and transitions between the different stages in a task shall not be ambiguous.
   **Source**: Literature Review 2.5.4, Requirements Analysis 3.2.3
   **Rational**: This will stop the task from being disrupted and therefore the child will not be wasting valuable learning time.

37. **Description**: The system shall not take longer than 10 seconds to load any task.
   **Source**: Requirements Analysis 3.2.3
   **Rational**: It was observed that children become impatient and frustrated when waiting for a new screen to load and keep clicking the mouse, as they don’t understand why it is taking so long.

38. **Description**: A limited number of colours shall be used in appropriate combinations. Colours will also be used in a meaningful and consistent way.
   **Source**: Requirements Analysis 3.2.3
   **Rational**: Too many colours can confuse the child, as well as being very distracting and taking focus away from the task at hand.

39. **Description**: It should be obvious which parts of the interface active and which parts are not.
   **Source**: Requirements 3.2.3
   **Rational**: The interface should be intuitive to use otherwise the child can become confused and frustrated, and this can detract attention away from the learning.

### 3.4 Conclusion

The requirements analysis and specification has formed an important foundation on which to build the computer-based tutor system. The requirements themselves were drawn from a variety of sources, which included the literature review, the stakeholders of the system and existing similar systems.

The literature provided a lot of valuable information particularly relating to learning styles and usability guidelines. There was a vast amount of information about the specific learning styles of children so the difficulty there was selecting the most appropriate material for this system. There was also a lot of information relating to the usability guidelines of a system, although the problem with this was finding material specifically written with children in mind, as their usability requirements are quite different to adults.

To gain a greater understanding of a child’s needs in relation to the system and to fill in the gaps in the literature, a group of children was included in the requirements analysis process. The children were asked about their opinions of their current language lessons, their ICT experience and their hobbies. This gave a good insight into the likes and dislikes of children within the target age range, but as it was only possible to interview children from the same class the results may not represent a complete picture of children across the whole of Key Stage 2.

Children are a key stakeholder in the system therefore it is important to gain their support to ensure the success of the system. There are a number of influencing tactics, as discussed in section 3.2.2, which can be used to encourage this support. These influencing tactics had to be adapted to be more appropriate for children, rather than including consultation and negotiation the child’s sense of fun and creativity was
appealed to, whilst also using child-specific motivational techniques such as arousing their natural curiosity.

The other key stakeholders in the system were the class teacher and school language co-ordinator. The lesson observation provided a useful insight into the current teaching techniques used within the language lessons and the follow-up interview clarified the reasoning behind the techniques the teacher chose to employ. The interview with the language co-ordinator provided further insight into the Modern Foreign Language curriculum within the school and also the current ICT resources and experience, which was used in setting the constraints of the system with regard to the environmental requirements.

The existing systems evaluation identified a wide range of design problems and usability issues that can occur with tutoring software for children, and that needed to be considered in the requirements specification and design stage to avoid repeating the same mistakes. The expert evaluation found problems by imitating the behaviour of a child, although as it is obviously hard for an adult to mimic a child’s thought processes exactly it was important to also observe real children using the system. The problem encountered with this process was although a lot of negative aspects of the systems were identified, positive aspects tended not to be.

The overall aim of this project is to produce a high fidelity prototype rather than a fully working system; therefore not all of the requirements specified will be addressed. It is also possible that some of the requirements may conflict, so it is important to find workable solutions for these during the design process, which will be carried out in the following chapter.
Chapter 4

Design

4.1 Introduction

The purpose of this chapter is to produce the overall design of the system based on the set of requirements established in the previous chapter. This chapter will cover the constraints of the final system and the system architecture, which will give a high level overview of how the system will be structured. It will then go on to discuss the various participatory design-based development processes the low fidelity prototype went through before the final prototype was produced.

Preece et al (2002) specify two types of design, the conceptual and the physical. Conceptual designs convey the functionality of the system, whereas physical designs capture the appearance of the individual screens. This chapter will aim to deal with both of these aspects of design.

It is important that the design process is user-centred, with the users involved in generating the ideas as well as providing feedback on the various low fidelity prototype designs. Simply involving the users in the requirements gathering process is not enough, as that stage involved thinking more abstractly about the system with nothing concrete to look at and discuss. Involving the users in the design stage is particularly crucial in the case of children since the target age group for the system (7-11 year olds) have not yet developed the required mental ability to comprehend such abstract concepts fully.

The design process will involve the production of various low fidelity prototypes, which are particularly suited to user-centred design, and children in particular, as they enable the design sessions to be interactive as well as being quick and easy to change. This is also essential because the design process should be an iterative cycle, going through the design, evaluation and re-design stages multiple times.

The end goal of the design process is to generate a final set of designs upon which the high fidelity prototype can be based which requires firstly for the constraints of this final prototype to be specified.

4.2 Constraints

As the aim of this project is only to produce a high fidelity prototype rather than a fully working system there are a number of constraints on the design and implementation.
The final system would include all of the vocabulary the children need to learn within Key Stage 2 as specified by the school’s language coordinator. This vocabulary will be divided up into the various language topics found in the language lesson plans developed by the language coordinator such as greetings, numbers, colours etc. These lesson plans can be found in the Design Appendix. For the purpose of this project only the functionality of one of these topics will be implemented as each topic is expected to follow a common structure, simply incorporating different vocabulary and consolidation activities and exploiting what has already been developed.

The content of the tutor will be suitable for all abilities, as unlike other subjects it is assumed that all the children will be starting from the same level and it is presumed they have no previous experience of the language. The language coordinator has provided a list of the basic vocabulary the children are expected to learn, so the learning content for the tutor will be taken from this.

Any sections for use by the class teacher only will also be excluded from the high fidelity prototype. As the children would not have access to these screens it is therefore not the main focus of the project.

### 4.3 System Architecture

The system requirements have been combined with the findings from the initial interface design evaluation to produce an overview of the basic architecture of the system and how the different parts of the system will be linked together, see Figure 4.1.

**Main Menu** – This screen allows the user to access the individual sections of the system, which include the reward screen, the teacher’s area, and each of the different units.

**Reward Screen** – This screen allows children to view the rewards that they have acquired for completing each unit, which satisfies functionality requirement 5 (section 3.3.3), which states, “the system shall reward the user for successfully completing a task”.

![Figure 4.1 – System Architecture](image)
**Teacher’s Area** – This screen is designed for use by the class teacher, which allows them to change certain settings such as the difficulty level and also track the progress of individual pupils.

**Units:**
All units will follow a common structure to satisfy functionality requirement 3 (section 3.3.3), which states, “each task shall follow a consistent routine”. The common structure also allows the user to apply this knowledge to all units and therefore satisfies usability requirement 35 (section 3.3.3), which states that the system should be easy to navigate as once the user has learnt to navigate through one unit they will be able to navigate through all units. Each individual unit will consist of the following screens:

**Lessons 1 and 2** – These screens are designed to be a lesson where the children will be presented with some new vocabulary.

**Activity 1 and 2** – These screens require the children to complete an activity based on the new vocabulary they have just been presented with before they can progress to the next screen.

**Game 1 and 2** – These screens require the children to complete a game based on the new vocabulary they have just been presented with before they can progress to the next screen.

Each unit will have an activity and a game based on the same vocabulary to satisfy functional requirement 8 (section 3.3.3), which states, “the tutor shall incorporate various different tasks to consolidate the same material”.

**4.4 Low Fidelity Prototype**

Low fidelity prototyping involves producing a prototype that has some elements of the final product but is a much simplified and normally incomplete version. It often uses materials that are very different from the final product such as paper and cardboard which enables the prototype to be produced quickly, thus providing early and essential feedback, and for it to be easily modified. For this reason it has been decided that producing a low fidelity prototype is the best way of beginning the design phase of this project as it is the most flexible way of exploring different designs and ideas.

It has been decided that paper prototyping is most appropriate for this phase of the project as using basic art supplies comes naturally to children so there is no need to teach them how to prototype in this way, as well as enabling easier and more rapid feedback from the designs. This prototyping technique will be used throughout the participatory design stage.

**4.4.1 Participatory Design**

Participatory design is when a system’s end users are involved in the design and development process of the system. Even if the users have been involved in the requirements gathering stage, as they have in this project, it is still important to include them in the design and development as often not enough is known about the users to make assumptions as to their exact needs and wants for the final system. Also even if it is possible for users to articulate what they actually want, it can be the case that this changes when they are actually given what they wanted.

It is essential that the actual end users are involved in the process rather than representatives such as their teachers, as they are not directly involved in using and learning from the system so therefore would not have the same thoughts and opinions as the children. This is particularly relevant in this case as the
differences between what an adult thinks a child would want and what a child actually wants can be vast because a child has quite different thought processes.

The users may be able to raise issues that the developer would never have even considered, but they cannot be expected to come up with ideas from scratch, as they are not experienced in developing systems. It is therefore necessary to use existing resources or to create basic low fidelity prototypes to prompt thought and discussion, as reacting to concrete information/designs is where the users will provide the most benefit.

“Evaluation is not just about the quality of technological solution” (Merkel et al, 2004), the users learning about technology and what it can offer can also be considered as an evaluation criterion within the participatory design exercise. It is important to understand that the users may not know the extent of the possibilities the system can offer, so a balance needs to be achieved between providing the user with feasible ideas in relation to the available technology and allowing them the flexibility of using their own imagination.

To maximise the benefit of involving children in the design process an existing technique called Cooperative Inquiry was used, which has been developed by Alison Druin at the University of Maryland. The stages involved in Cooperative Inquiry and the results gained from carrying out this process are described in the following section.

4.4.2 Cooperative Inquiry

Cooperative Inquiry consists of three parts; contextual inquiry, participatory design and technology immersion. In this project the first two parts have been followed, but technology immersion was not considered appropriate in this case as the final product will be developed using technology the children are already familiar with.

Contextual inquiry involves observing the children using similar existing systems, which in this case was two language tutoring systems called Early Start Languages and Petit Pont. The results of this observation can be found in the Requirements chapter, section 3.2.3, as this was carried out as part of the requirements analysis process. It does however have two purposes as it also forms part of the design process because it helps the children to start thinking about what a language tutoring system could do, and what they like and dislike about it. Children in particular have problems thinking about abstract concepts such as this, therefore it is important to provide them with concrete examples to help them. The results gathered from the observation have been included in the requirements specification of the system.

The second stage is participatory design; this involves the children using art supplies to create a paper-based interface design. For this project to achieve continuity, flow, and rational design decisions based on assessment of existing solutions the same two children observed interacting with the existing systems were involved in the participatory design. They were given a blank sheet of A3 paper each, along with colouring pencils, a selection of clipart, glue, coloured paper and scissors, and asked to create an interface for helping other children learn about the topic of colours in French. They were supplied with a list of the French vocabulary for them to incorporate if they required it. Once the children had completed their designs they were asked to explain exactly how a user would interact with the interface and what the functionality of each interface element did.

The interface designs can be found in the Design Appendix along with the child designer’s explanation of the functionality.

The findings from the participatory design exercise were then used as a basis for producing the initial low fidelity prototype interface designs, which are described in more detail in the following section.
4.4.3 Initial Interface Designs

Two different sets of low fidelity paper prototype interface designs were produced, which included the main menu, see below, and an example screen from one of the units.

The first design is based on a holiday in Paris, with postcards of various landmarks in the city to help the children relate to the country where the language is spoken. It would also enable possible cross-curricular learning with the Geography curriculum and therefore satisfies data requirement 14 (section 3.3.3), which states “information relating to the culture of the country where the foreign language is spoken should be incorporated into the system”.

![Design 1 Main Menu](image)

**Figure 4.2 – Design 1 Main Menu**

The second design is based on a treasure hunt within the Château de Versailles, led by Marie Antoinette, a prominent figure in French history. This would enable possible cross-curricular learning with the History curriculum and also satisfies data requirement 14, as stated above. The full set of initial designs can be found in the Design Appendix.
The interface designs were then taken into Jotmans Hall School and shown to the language co-ordinator and a group of ten year 5 children in pairs. Grouping the children in pairs with their friends allowed them to feel more relaxed and comfortable during the evaluations, as well as also allowing them to expand on each other’s ideas, therefore increasing the productivity of the sessions. Their thoughts and opinions were noted down and have been summarized below.

Language Co-ordinator:

*Good points:*
- She liked both the characters that help guide the child through the system.
- She thought the first design was clearer and it was easier to see what you had to do.
- She thought the first design would appeal more to younger children.
- She liked both of the designs, but preferred the first design.

*Improvements:*
- The navigation on the second design was not so clear to her.

Year 5 Children:

*Good points:*
- The children all liked the overall design, layout and colour schemes of both designs, and had no problems reading the text.
- They thought the navigation was straightforward, the designs were well spaced out and liked the bright colours.
- They also liked the fact the designs both had a ‘French’ style.
They all liked the reward schemes of both designs and suggested a beret, dolls, coins, books, or other French themed items as well as items relating to the unit as possible souvenirs to collect for the reward scheme of the first design. They thought the reward schemes made the learning fun.

The children liked the old fashioned look of the second design and the fact it gave you a bit of an insight into French culture.

One child liked the fact the navigation used different elements such as the doors and magnifying glasses, rather than only using footprints in the first design.

Overall the children liked both designs, but the majority preferred the first design because of the look of the interface, the bright colours and the pictures. Some of the children thought that it may be more suitable for younger children, and the second design to be more suitable for older children.

**Improvements:**

- One child suggested replacing the magnifying glasses on the second design with jewels.
- Another suggestion was that you could click on the pictures in the first design to find out more information about the French places.
- A couple of the children suggested that the French and English could be displayed on the screen to help learn the vocabulary, and the text could be divided up to help learn the pronunciation.
- The children did not think that help was necessary on the main screen as it was quite straightforward to use.
- They also suggested highlighting the units that had been completed in some way, including worksheets that can be printed out for each unit and to have a separate parent/teacher area.

During the evaluation the language co-ordinator and the children were also asked about possible games and activities that could be included in the system. Their suggestions included the following:

- Multiple choice question and answer to help with conversations.
- Games involving movement such as bowling.
- Games involving aiming something such as darts.
- Maze games.
- Moving something round an obstacle course like a speedboat.
- Typing games.
- Word searches.
- Matching games.
- Puzzles.
- Card games such as twenty ones.
- Scrabble.
- Memory games.
- Deal or No Deal.
- Scrambled words.
- Customised stories.
- Picture games.

The language co-ordinator also suggested that when learning vocabulary the words should always be supported with a picture and possibly have some form of movement when the word is being spoken. She did not think that the children should be given the option of an English translation, as this encourages them to take the easy route and not have to understand the French themselves.

The initial evaluation session in the school generated a number of ideas and raised various areas of improvement that will need to be taken into consideration during the final re-design of the low fidelity prototype. These design decisions will be discussed in the following section.
4.5 Low Fidelity Prototype Re-Design

A final set of low fidelity prototype designs were produced for each screen, which will be implemented in the high fidelity prototype. The designs can be found in the Design Appendix and include the following screens:

- Main menu
- Reward screen
- Numbers Vocabulary 1-5
- Numbers Activity for 1-5
- Numbers Game for 1-5
- Numbers Vocabulary 6-10
- Numbers Activity for 6-10
- Numbers Game for 6-10

The intended functionality of these screens is summarised in Table 4.1. A network diagram illustrating the various links between the screens can be found in the Design Appendix.

<table>
<thead>
<tr>
<th>Screen</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Menu</td>
<td>The first screen the users come to which enables them to navigate to the rest of the system.</td>
</tr>
<tr>
<td>Reward Screen</td>
<td>Allows user to view all the rewards they have accumulated.</td>
</tr>
<tr>
<td>Numbers Vocabulary 1-5</td>
<td>Introduces the spellings and pronunciation of the numbers 1-5 in French.</td>
</tr>
<tr>
<td>Numbers Activity for 1-5</td>
<td>Drag and drop activity where users have to match up numbers with the correct image.</td>
</tr>
<tr>
<td>Numbers Game for 1-5</td>
<td>Wordsearch game where users have to find to numbers within the grid.</td>
</tr>
<tr>
<td>Numbers Vocabulary 6-10</td>
<td>Introduces the spellings and pronunciation of the numbers 6-10 in French.</td>
</tr>
<tr>
<td>Numbers Activity for 6-10</td>
<td>Spelling activity where users have to type in the correct spelling of each of the numbers.</td>
</tr>
<tr>
<td>Numbers Games for 6-10</td>
<td>Maths game where users have to correctly solve the maths problems to help the frog cross the pond.</td>
</tr>
</tbody>
</table>

Table 4.1 – Summary of Screen Functionality
4.5.4 Main Menu

The overall design has not changed much from the initial low fidelity prototypes that were shown to the children as they liked it and found it appealing.

The title ‘French Footsteps’ has been changed to make it more prominent within the screen. The actual names of the units have also been added as suggested by the children; this will enable them to know the type of vocabulary they can expect to learn by completing the unit and also aids the navigation of the system as a whole.

Finally as the children seemed to intuitively understand interaction with the main menu the ‘Get Help’ link has been removed and replaced with a link to the ‘Teacher’s Area’, although this section of system will not actually be implemented in the high fidelity prototype.

![Figure 4.4 – Main Menu](image)

4.5.5 Reward Scheme

This screen has been included in the design to enable the system to meet functional requirement 5, which can be found in section 3.3.3, and states that “the system shall reward the user for successfully completing a task”.

The reward scheme is designed to fit the theme of the tutor, which is based on a holiday in Paris. After the user completes each unit they are rewarded with a different French souvenir, which is placed in their suitcase. The overall goal of the system is to fill up the suitcase with the various souvenirs.

The French-themed souvenirs were chosen as one of the children’s main motivations for learning a language is so they can speak the language in that country. The children also demonstrated a keen interest in the French culture and suggested the French-themed souvenirs during the initial design evaluations.
The user can view the suitcase at any time by clicking on the ‘View Suitcase’ link on the main menu. This also enables the user to track their progress, as the number of souvenirs they have collected corresponds to the numbers of units they have completed.

![My Suitcase](image)

**Figure 4.5 – Reward Screen**

### 4.5.6 Unit Structure

Each of the individual units will follow the same common structure to enable the system to meet functional requirement 3, found in section 3.3.3, which states, “*each task shall follow a consistent routine*."

The unit will begin by presenting the user with some basic vocabulary, which will then be followed by an activity and a game based on this vocabulary. Next, additional vocabulary will be presented to the user, which will again be followed by an activity and a game based on the additional vocabulary.

The reason for the vocabulary/activity/game structure is to enable the system to meet functional requirement 8, again in section 3.3.3, which states, “*the tutor shall incorporate various different tasks to consolidate the same material*”. The user will get the opportunity to practice the vocabulary twice to give them a better chance of remembering it.

The overall design of each unit will also follow a common composition throughout the system and is described in more depth in the following sections.

**Presentation**

The presentation of each of the unit screens follows a consistent format, with the elements of the interface common to each screen placed in the same position. The colour scheme of red, white and blue has been chosen to continue the French theme of the system, as well as making the screen bright and colourful to
make it appealing to children. This design aspect has been influenced by the designs produced by the children during the participatory design exercise.

The navigation functionality has been separated from the rest of the screen to clearly indicate to the user it is independent of the lesson/activity/game in the main section of the screen. To ensure the user is able to navigate easily through the system and does not get ‘lost’, the unit number and title is constantly displayed in the top right-hand corner and the footsteps mark the user’s progress through each of the unit screens.

**New Vocabulary**

There are two screens within each unit that will present a new set of vocabulary to the user. The written version of the word is reinforced by an image as well as in audio format, which is played when the user clicks on the image. There is no time limit to the lesson screens so the user can stay on the screen as long as they require, learning and rehearsing the vocabulary. They are also able to return to the screen at any point during the unit by clicking on the corresponding footstep to revise any vocabulary they may have forgotten.

![Figure 4.6 – Lesson Screen 1](image)

**Activities and Games**

Each lesson screen is followed by one activity screen and one game screen to help reinforce the language that has just been learnt. This allows the child to practice the language in various ways such as spelling and solving problems. It also allows for cross-curricular learning with subjects such as mathematics that children are already familiar with.

Each activity and game provides the children with immediate feedback as well as praise for getting the correct answer. In the games children are rewarded with additional feedback such as animations. To ensure the children are motivated to complete the activity/game and do not just skip over it to reach the end of the unit the next button would be disabled until the activity/game has been completed.
Help System

There is a French-themed animal character in the top left-hand corner of each screen who provides the user with the instructions for the task. The inclusion of this character has been influenced by the participatory design exercise in which one of the designs featured a similar style character that helped the child. Additional help relating to the screen can be found on separate help pages by clicking on the ‘Get Help’ icon at the bottom.

In addition to involving the end users in the evaluation of the low fidelity prototype designs it is important to also involve someone with HCI expertise. This allows possible underlying usability issues to be identified that the users would not be able to identify from a paper-based prototype. The results of this evaluation can be found in the following section.

4.5.7 HCI Expert Interface Evaluation

The final low fidelity prototypes were shown to a HCI PhD student who provided an expert evaluation of the HCI aspects of the design. The findings of this session will be taken into account in the design of the high fidelity prototype. A summary of these findings can be found below, along with the possible design solutions that could be implemented in the high fidelity prototype:

The overall design is good and would be appealing to children.
- On the main screen the postcards look like they are click-able, and would draw the child’s attention rather than the footsteps, which are the key element of the interface as they provide access to the content of the tutor.
  **Design Solution:** The footsteps could be moved to the top of the screen and the postcards could be reduced in size to detract the attention away from them and onto the footsteps.
- The first screen of the Numbers unit has multiple purposes; it is a welcome screen as well as containing the vocabulary for the first lesson.
  **Design Solution:** This screen could be divided up so there is a separate welcome screen that provides an overview of the unit to the user.
The unit screens look quite cluttered, which makes it hard to concentrate on the main focus of the screen.  
**Design Solution:** The footsteps could be moved to the bottom of the screen between the back and next buttons so all the navigational features are grouped together. The additional help could be transferred to be accessed via the on screen help character so the user does not have to switch screens, this means the ‘Get Help’ icon can be removed to make way for the footsteps.

- The vocabulary on the first and fourth screens should also be divided up more clearly.  
  **Design Solution:** A background could be added to each of the images to divide up the page more clearly as well as better highlighting the new vocabulary to be learned.

- The purpose of the drag and drop activity on the second screen is not immediately obvious.  
  **Design Solution:** This purpose of the activity could be made clearer by putting a differently coloured border around the drag-able objects and giving a shadow to the drag-to target areas.

- The layout of the game on the sixth screen should be rearranged to give less emphasis to the frog pond and more emphasis to the problem the child needs to solve. It could also possibly include an explanation of how to play the game.  
  **Design Solution:** The frog pond could be made smaller and moved to the side, and the maths problem could be made bigger and highlighted using a coloured background to make it more prominent. The frog character could provide additional help on how to play the game.

- The back button is redundant as you can navigate to the previous screen using the footsteps. Also there is no way of getting back to the main menu from the unit screens.  
  **Design Solution:** A main menu button could replace the redundant back button.

The re-design of the low fidelity prototype is an essential process as it is highly unlikely any designer will get it right first time. Therefore incorporating the various feedback and ideas obtained from the initial evaluation sessions will help to ensure that the high fidelity version will better match the user’s expectations and needs.

### 4.6 Conclusion

The low fidelity prototype has now been taken through the various stages of the design cycle. It was important to involve the children in the design evaluation as well as the actual design generation, as important ideas and feedback would have otherwise been overlooked or left out at these stages. The expert HCI evaluation provided a further insight into the potential flaws in the design construction that the children would not have necessarily have been aware of whilst considering the system in a more abstract form.

The project could have benefited by further iterations through the design cycle with the final low fidelity prototype designs being taken back into school for further evaluation before implementation. This has unfortunately not been possible due the time constraints of the project, as well as the availability of the school involved.

In conclusion the design process that has been followed has successfully enabled the initial low fidelity prototype designs to be developed into an appropriate and workable solution that can now be developed further into the final high fidelity prototype. This process will be discussed in the next chapter.
Chapter 5

Implementation and Testing

5.1 Introduction

This chapter will discuss the process that took place to convert the paper-based low fidelity prototype designs into a computer-based high fidelity prototype, which could be interacted with.

The first step was to decide upon the implementation language to be used, this decision was based upon the following criteria:

- The implementation language needs to be able to support rapid development due to the short time frame of development.
- It should be able to support the easy implementation of the attractive and detailed graphical user interfaces that have been developed in the design stage of the project.
- The language should be simple enough to be easily maintained by someone with limited development experience, to enable it to be taken on by the school once the initial implementation has been completed.
- It should also be straightforward for any changes or additional functionality to be implemented, as once the high fidelity prototype has been completed further work would need to be done to turn it into a fully functioning system.
- The system should be able to run quickly as children would become impatient waiting for graphics to load etc.

The languages that were investigated in respect to these criteria were Java and Macromedia Flash 8, both of which have the capability to support GUIs. Both languages can produce visually attractive interfaces and offer a powerful set of features and functionalities.

An issue with using Java arose when it came to its ability to support rapid application development, the various libraries for GUIs require significant effort to learn as well as being considerably complex to learn from scratch. Flash, on the other hand, can support the quick implementation of a system due to its straightforward usage, along with the ease of importing graphics directly from Adobe Photoshop to its libraries. This would also ensure it would be easy for someone else to maintain in the future. The other problem with Java is the runtime is huge compared to Flash, which would cause the system to run much more slowly and therefore could be quite frustrating for the child when using the system.

The capabilities that Macromedia Flash 8 can offer will be discussed in further detail in the next section.
5.2 About Flash

Macromedia Flash is a powerful communication tool that allows you to use a combination of graphics, animation, sound and interactivity to produce professional looking applications within a relatively short space of time. The Flash interface broadly consists of the stage, the timeline and the library.

Each Flash file is divided into scenes and within each scene is a series of frames. The stage is the workspace where each frame is created and shows the frame the user is currently in the process of editing.

The timeline shows the sequence of frames and layers that make up the scene and any actions that have been applied to them. It allows the order of the frames to be seen as well as how they are linked, and it can be directly manipulated to alter these. It also provides a view as to how long the whole scene will last. The layers allows the media elements within each frame to be stacked, which can be extremely useful when every element is not required to be visible all of the time.

The library stores all the media elements used in the Flash file and these are known as symbols. There are various types of symbol, which include graphics, movie clips and buttons. The library stores the ‘master’ symbol and any changes to the master are immediately reflected in all the instances of the symbol on the stage. The master symbol only needs to be downloaded once no matter how many instances have been used in the Flash file.

Movie clips contain interactive controls and sounds, and follow their own internal timeline that is independent of the main one allowing an animated movie to be placed in a single frame of a scene. A graphic is a static image and a button is an interactive symbol that can respond to mouse events.

Flash uses a programming language called ActionScript, which allows you to add interactivity to the Flash file. For instance stopping and starting the movie so some parts only run on command. It is good practice to put all of the code in an ‘Actions’ layer rather than directly attaching the code to specific media elements. This means it can all be found in one place allowing for easier debugging and maintenance.

The next section will discuss the structure that the high fidelity prototype will follow within the Flash environment.

5.3 System Architecture

As it has been decided that only one of the units will be implemented there is no need for any information relating to the progress through each unit to be saved. Therefore everything can be hard-coded into Flash rather than being stored in a central database, which will greatly reduce development time.

In the final system this information will obviously need to be stored in someway therefore the Flash files will be divided up into the individual screens so the information can be submitted to the database at the end of each activity/task.

See below for a breakdown of the individual screens. Please note that additional screens at the start and end of the unit have been added in accordance with the expert evaluation that was carried out at the low fidelity prototype stage. The wordsearch game has also been replaced with a True or False game, which is a more appropriate way to test a child’s learning.

- **Main menu** – This allows access to the Numbers unit and the Suitcase.
- **Suitcase** – This stores all the souvenir rewards that have been collected.
- **Intro** – This introduces the unit and explains how each part of the interface works.
- **Numbers 1 to 5** – This presents the numbers 1 to 5 in French and allows the pronunciation to be heard by clicking on each of the images.
- **Drag and Drop Activity** – This activity involves dragging the French numbers that have just been learnt to the correct image.
- **True or False Game** – This game involves specifying whether the French word has been matched to the correct number by clicking ‘Vrai’ or ‘Faux’.
- **Numbers 6 to 10** – This presents the numbers 6 to 10 in French and allows the pronunciation to be heard by clicking on each of the images, in the same way as for the Numbers 1 to 5.
- **Typing Activity** – This activity requires each of the numbers to be spelt correctly in French, the spellings can be checked by clicking on an ‘OK’ button.
- **Frog Game** – This game involves solving mathematical problems in French. The aim is to get the frog across the pond by clicking on the correct answers.
- **Final Screen** – This presents the user with the souvenir prize for the unit and then places it in the suitcase.

See the Implementation Appendix for a network diagram illustrating this structure.

### 5.4 Graphics

To further reduce development time the majority of the graphics were imported from the low fidelity designs that had been previously developed in Adobe Photoshop. The background was imported separately to the individual graphics, as they needed to be made interactive.

The following graphics are common to all screens within the unit. They have been developed in Photoshop, imported into Flash and converted into symbols.

Figure 5.1 is displayed in the top right hand corner of every screen and references the current unit. This is in response to usability requirement 35, found in section 3.3.3, which states that “the system shall be easy to navigate and transitions between the different stages in a task shall not be ambiguous”. If the user always knows where they currently are within the system it will make it easier to navigate to where they want to go.

![Figure 5.1 – Unit Title](image)

Figure 5.2 is displayed in the bottom left hand corner of every screen and allows the user to return to the main menu at any time by clicking on it.

![Figure 5.2 – Main Menu Button](image)

Figures 5.3a and 5.3b are displayed in the bottom right hand corner of every screen. Figure 5.3a is the inactive version and Figure 5.3b is the active version, allowing the user to go to the next screen of the unit.
This is in response to usability requirement 38, found in section 3.3.3, which states that “it should be obvious which parts of the interface active and which parts are not”.

![Figure 5.3a – Inactive Next Button](image)

Figure 5.3a – Inactive Next Button

![Figure 5.3b – Active Next Button](image)

Figure 5.3b – Active Next Button

Figure 5.4 is displayed to indicate if the lesson screens where new vocabulary is introduced, to allow these screens to differentiate from the activity and game screens, which need to be completed before the user moves on.

![Figure 5.4 – Lesson Symbol](image)

Figure 5.4 – Lesson Symbol

Figure 5.5 is the character that supports the child through each unit and gives additional help where it is needed when the user clicks on the ‘help’ button. This is in response to user requirement 21, found in section 3.3.3, which states “the tutor should include an animated pedagogical character to help guide the child through each task”. The frog character was chosen because of its French associations.

![Figure 5.5 – Help Character](image)

Figure 5.5 – Help Character

Figure 5.6a and 5.6b are used to track the users progress through the unit. The red coloured footprint indicates the screen is currently in progress and incomplete. The green coloured footprint indicates the screen has been completed; the user is also able to go back to a previous screen by clicking on the corresponding green footprint. These graphics are also in response to usability requirement 35, as they state that “the system shall be easy to navigate and transitions between the different stages in a task shall not be ambiguous”. The footprints allow backward navigation as well as tracking the specific point in the unit the user has reached.

![Figure 5.6a – Incomplete Screen](image)

Figure 5.6a – Incomplete Screen

![Figure 5.6b – Completed Screen](image)

Figure 5.6b – Completed Screen
5.5 Unit Implementation

The learning content for the unit has been taken from the list of vocabulary specified by the language coordinator for teaching the Numbers in French.

Each unit is broadly divided into three parts. The lesson screens introduce new vocabulary, the activity screens require the user to complete an activity based on the vocabulary that has just been introduced, and finally the game screens require the user to complete a game based on the same vocabulary. The implementation of each of these parts will be described in greater depth in the following sections. Please note the audio throughout the unit consists of original recordings provided by Sylvie Gerard, a French PhD student.

5.5.1 Lesson Screens

The lesson screens follow a common format, which is relatively simple. The screens consist of a single frame, as there is no animation and little interaction with the interface. They both have three layers, which can be seen in Figure 5.7.

![Figure 5.7 – Lesson Screen Layers](image)

The background layer contains the background graphic, the actions layer contains the ActionScript, which allows the audio to be played and the help text to be displayed (see Figure 5.8), and the graphics layer contains all of the images.
stop();

//instructions audio
var snd6 = new Sound();
snd6.attachSound("three");
snd6.start(0,1);
//default to not show help
var help = 0;
//show help on click
helpMC.onRelease = viewHelp;

//numbers 1-5 audio
var snd = new Sound();
var snd2 = new Sound();
var snd3 = new Sound();
var snd4 = new Sound();
var snd5 = new Sound();
snd.attachSound("un");
snd2.attachSound("deux");
snd3.attachSound("trois");
snd4.attachSound("quatre");
snd5.attachSound("cinq");

//set instruction text
speech = "D'abord les chiffres \nde 1 a 5...";
accent = "/";

//check to see if instructions or help is currently displayed then swap the text
function viewHelp(){
    if (help eq 0) {
        speech = "Click on the pictures to\nlisten to the numbers."
        accent = ";";
        help = 1;
    } else {
        accent = "/";
        speech = "D'abord les chiffres \nde 1 a 5...";
        help = 0;
    }
}

Figure 5.8 – Lesson Screen ActionScript Screen

5.5.2 Activity Screens

There are two different activity screens within the unit, a drag and drop activity based on the numbers 1 to 5 and a typing activity based on the numbers 6 to 10. Both activities are described below.

Drag and Drop Activity
The drag and drop activity involves dragging boxes containing the French numbers 1 to 5 to the corresponding target area next to the correct picture. It consists of two frames, the first frame is where the drag and drop is performed, and the second frame is when the feedback is given for completing the activity and the users being allowed to progress to the next screen. The screen comprises of four layers. The background and actions layers are consistent with all other screens, the dragger layer contains the objects that can be dragged and the dragto layer contains all the target areas for the objects to be dragged to.

The objects that are dragged are Movie Clip symbols, which contain code that can check if they have been dropped on the correct area of the screen (see Figure 5.9).
Typing Activity

The typing activity involves typing the correct spelling of the French numbers 6 to 10 into the input boxes. It consists of two frames, the first frame is where the spellings are initially input and the second frame is where the user is given feedback for completing the task and is allowed to progress to the next screen. The ActionScript code for checking the spellings can be found in Figure 5.10. There are three layers, the background and actions layers along with the textboxes layer that contains all the input boxes.
//check answers are correct, if they are go to next screen
function checkNo() {
    var allCorrect = 0;
    if (six eq "six" || six eq "Six" || six eq "SIX") {
        sixCorrect = "Oui";
        sixWrong = "";
        allCorrect += 1;
    } else {
        sixWrong = "Non";
        sixCorrect = "";
    }
    if (seven eq "sept" || seven eq "Sept" || seven eq "SEPT") {
        sevenCorrect = "Oui";
        sevenWrong = "";
        allCorrect += 1;
    } else {
        sevenWrong = "Non";
        sevenCorrect = "";
    }
    if (eight eq "huit" || eight eq "Huit" || eight eq "HUIT") {
        eightCorrect = "Oui";
        eightWrong = "";
        allCorrect += 1;
    } else {
        eightWrong = "Non";
        eightCorrect = "";
    }
    if (nine eq "neuf" || nine eq "Neuf" || nine eq "NEUF") {
        nineCorrect = "Oui";
        nineWrong = "";
        allCorrect += 1;
    } else {
        nineWrong = "Non";
        nineCorrect = "";
    }
    if (ten eq "dix" || ten eq "Dix" || ten eq "DIX") {
        tenCorrect = "Oui";
        tenWrong = "";
        allCorrect += 1;
    } else {
        tenWrong = "Non";
        tenCorrect = "";
    }
    if (allCorrect eq 5) {
        speech = "Super!";
        accent = "";
        gotoAndPlay(2);
    }
}
5.5.3 Game Screens

There are also two different game screens within the unit, a true or false game based on the numbers 1 to 5, and a mathematical problem solving game based on the numbers 6 to 10. A description of each game can be found below.

True or False Game

The true or false game involves specifying whether the statement is right or wrong by clicking on the correct box (‘Vrai’ for true or ‘Faux’ for false). If you get the correct answer then the user is rewarded by one of the frog images being animated. This is the most complicated screen with 77 frames and 7 layers, see Figure 5.11.

![Figure 5.11 – True or False Game Timeline](image)

The complexity of this screen is due to the 5 individual frog graphic animations. The actions, background, text and graphics layers contain similar elements to previous screens. The fade in/out, expand and spin layers contain transition effects that the frogs perform if a correct answer is obtained. Movie clips are used for the other two frog animations along with motion tweening, which allows the key frames of the animations to be specified and automatically fills in the intermediate frames. If the wrong answer is specified these animation frames are skipped and the user receives alternative feedback. The ActionScript code for checking the answers is shown in Figure 5.12.
Mathematical Problem Solving Game (Frog Game)

This game involves solving French number problems to help the animated frog hop across the other side of the pond. The screen consists of 6 frames, each with a different maths problem and 4 layers, background, action, graphics and text as with previous screens. The frames are played in sequence and the next frame is only displayed once the user has clicked on the right answer. The frog animation is a Movie Clip symbol and is played in parts with the frog hopping to the next lily pad after each correct answer. The ActionScript code for checking for the correct answer can be found in Figure 5.13.

Figure 5.12 – Checking True or False answers ActionScript Code
//answers on mouse roll over and select
b1.onRollOver = over;
b1.onRollOut = out;
b1.onRelease = incorrect;
b2.onRollOver = over;
b2.onRollOut = out;
b2.onRelease = incorrect;
b3.onRollOver = over;
b3.onRollOut = out;
b3.onRelease = correct;
b4.onRollOver = over;
b4.onRollOut = out;
b4.onRelease = incorrect;
b5.onRollOver = over;
b5.onRollOut = out;
b5.onRelease = incorrect;

//incorrect audio
var snd = new Sound();
snd.attachSound("frogSE");

//if incorrect display feedback and play audio
function incorrect() {
    speech = "Non, essayes \encore...";
    accent1 = "";
    accent2 = "";
    snd.start(0, 1);
}

//if correct go to next frame
function correct() {
    gotoAndPlay(2);
}

Figure 5.13 – Checking Frog Game answers ActionScript Code

5.6 Reward Scheme Implementation

The user receives a reward at the end of each unit, which is then stored in the suitcase. As the implementation of only one unit is required there is no need for any information in relation to the reward scheme to be saved. Therefore a basic reward scheme has been implemented to give the user an idea of how the final thing would function.

The prototype is set-up as if all units have been completed with the exception of the functioning Numbers unit. The souvenirs for each of the completed units are shown in the suitcase, along with an empty space for the souvenir from the Numbers unit (Figure 5.14a). After completing the Numbers unit the user is presented with the souvenir and then it is placed in their suitcase (Figure 5.14b). They are then taken to an alternative menu screen where all the units are shown as completed.
5.7 Testing

To check the tutoring system was functioning correctly ongoing functionality tests were carried out after the completion of each screen. Once all of the functionality had been implemented black-box testing was carried out on each section to verify it performed as expected and that the screens have been integrated correctly. This type of testing involves studying the inputs and the related outputs, and determining if the actual results matches the expected result. See the Implementation Appendix for the results.

The black-box testing followed the path through the system the user is expected to take (see Implementation Appendix). It is not necessary to test any alternative paths as the system has been designed in such a way to restrict the user from following the wrong route as well as clicking on anything that might cause an error. This lock-down of functionality has been implemented in response to usability requirement 31, found in section 3.3.3, which states, “errors shall be prevented where possible, and if they do occur a simple explanation should be provided”.

System testing will be carried out in greater depth by the end users during the Evaluation chapter of the project, as the user experience of the system is one of the main focuses of this project.

5.8 Publication

To allow users to easily access the tutoring system it was decided to publish it to the Internet. The system can then be run on any PC that is connected to the Internet and has Flash installed, which can be downloaded for free from the Adobe website. The publication of the system involved exporting each of the Flash files as *.swf movies and then embedding them in separate html files stored on the university web server. The finished prototype can be found at: http://people.bath.ac.uk/cs3ljb/Tutor/main.cfm
5.9 Conclusion

This chapter has detailed the process that has been undertaken in order to produce the final high fidelity prototype. Full source code listings for the system and a complete series of screenshots can be found in the Implementation Appendix.

Macromedia Flash has proved to be a highly flexible tool, which has allowed the prototype to be implemented quickly but to still have the professional look of a finished system.

To develop the system into the final product a database would need to be used to store information relating to the progress the user has made through the program. To insert information into the database and to query the existing data a programming language that provides an interface between the database and the HTML pages would need to be used in addition to the ActionScript code within the Flash files. Cold Fusion has been identified as one of the most suitable ways of providing this interface, as it is extremely good for rapid development as well as being easy to learn and integrate into existing HTML pages. Therefore the HTML pages have actually been saved as Cold Fusion enabled pages to allow for the easy inclusion of this functionality. The additional units would follow the same structure as previously implemented Numbers unit, only with alternative vocabulary relating to the topic of that unit.

To ensure the high fidelity prototype meets the user's expectations and needs it is necessary to carry out user evaluation, the details of which will be discussed in the next chapter. This would allow any potential issues with the systems functionality or user experience to be resolved before the final product is completed.
Chapter 6

Evaluation

6.1 Introduction

The purpose of evaluation is to ensure there is an understanding between the designers and the users, to
make certain that the user’s needs for the system have been interpreted correctly by the designer. It is
important to assess the usability of the system to ensure the interactions between the user and the system
have been highly optimised, as has been previously discussed in section 2.5.1. Therefore in order to
determine if the high fidelity prototype that has been developed meets the user’s needs and expectations it
needs to be subject to some form of evaluation process.

There are various different evaluation methods in HCI that can be employed; in this case it is important that
both the usability of the system and the child’s learning are assessed. This chapter will cover the results
and analysis of both of these tests. The usability being assessed by gathering feedback from both the
children and the language coordinator at Jotmans Hall Primary School, followed by the learning being
analysed by testing the children before and after using the system.

It has been decided that rather than using the more informal discussion-based evaluations that were
employed during the low fidelity prototype development stage, a more formal framework-based approach
will be used to enable the high fidelity prototype to be evaluated more systematically and in greater depth.

Preece et al (2002) specify an evaluation framework called the DECIDE framework which will be used to
carry out the evaluation sessions for this project. Using the DECIDE Framework allows the evaluation to
be clearly structured and ensures that it is planned appropriately.

The DECIDE Framework consists of the following stages:

- Determine the goals and Explore the questions
- Choose the evaluation paradigm and techniques
- Identify the practical issues to be addressed
- Deal with ethical issues
- Evaluate, analyse and present the data

Below each of the stages are discussed in greater depth in relation to this project.

6.1.1 Determine the goals and Explore the questions

This stage involves specifying the high level goals of the evaluation and the questions that need to be answered in order to establish whether these goals have been met. The goals and questions that should be asked in this case are as follows:

1. Check that the tutoring system meets the children’s expectations –
   - What do the children like/dislike about the system?
   - Is there anything they would change?
   - Did they find the system interesting to use?
   - Did they find the interface appealing?
   - Was the system fun and enjoyable to use?

2. Ensure the system is suitable for children –
   - Is the language at an appropriate level for the children to understand?
   - Does the system contain content suitable for children at Key Stage 2?
   - Was there suitable feedback?

3. Investigate the usability of the system –
   - Was there anything the children found particularly hard/easy to use?
   - Was it easy to navigate?
   - Is there appropriate help and support?

4. Investigate the effect the system has on the children’s language learning –
   - Was the system challenging?
   - Did the children learn anything from using the system?

6.1.2 Choose the evaluation paradigm and techniques

To verify that each of the high-level goals has been achieved the method of evaluation to be taken is the next aspect that needs to be considered. A field study was the chosen paradigm as it allows the user’s natural behaviour to be observed in a natural environment. It enables the tutoring system to be checked in relation to meeting the user’s expectations and for any usability problems to be assessed.

A combination of techniques will be employed to investigate each of the different goals within the chosen evaluation paradigm. This includes observing the users interacting with the system as well as informally interviewing them to gather their feedback on the system. As the effect the system has on a child’s language learning also needs to be evaluated, elements from the usability testing paradigm will also be
included. User testing is a technique of measuring this by administering short before and after tests to evaluate any effect the system may have had.

6.1.3 Check the practical issues to be addressed

There are various practical issues that need to be considered before carrying out the evaluation sessions. These include determining the users that are going to be involved, any specialist facilities or equipment that may be required, the time and budget constraints and the expertise the evaluators require.

For this project the users that need to be involved in the evaluation are children from Key Stage 2 (aged 7-11) as well as the language coordinator to provide a teacher’s view of the system. It is important children are screened to ensure that a fair cross-section is used, taking into account ability levels and previous language learning experience.

The necessary equipment needed for this evaluation is a PC with speakers. It is important that the computer is in a separate room away from too many distractions and any noise that may prevent the audio being heard correctly. For the duration of this evaluation Jotmans Hall Primary School has provided use of the SEN room, which fulfils these requirements.

It is hard to determine in advance exactly how long each evaluation session will take, but a week has been allowed in which to carry out the sessions. It is important this time is used to maximum benefit as the school then has a two-week vacation so evaluations will not be possible after this time. The budget does not need to be considered in this case, as the participants will not be paid.

The evaluation sessions have been designed to be carried out by one evaluator and do not require any specific expertise.

6.1.4 Decide how to deal with the ethical issues

When involving human participants it is important to ensure the evaluation sessions are carried out in an ethical way. The school has been given an ethics checklist (see the Evaluation Appendix) that provides them with all the necessary information with regards to the projects, which will allow them to give consent for the children to take part on their behalf.

The purpose of the session will be explained to each child before beginning the evaluation, as well as exactly what the session will involve. They will be made aware they can stop the session at any time if they feel at all uncomfortable. All data collected will be recorded anonymously so none of the children involved can be identified.

6.1.5 Evaluate, interpret and present the data

For this stage the type of data being collected needs to be considered in advance to ensure it is reliable, valid and free from bias wherever possible. Each of the evaluation sessions will follow a consistent structure to ensure that the results produced are reliable. The environment the evaluation is performed in
will try to emulate as closely as possible the real life setting in which the child would be using the tutoring system in to increase the validity of the results. Finally the questions directed to the participants will be designed to ensure they are open and not leading in any way.

The results of the evaluation process are discussed in the following sections.

6.2 Usability Evaluation

To determine the overall usability of the tutoring system a series of evaluation techniques have been employed.

Observations and interviews are frequently used as they provide a valuable insight into the user’s individual thoughts and behaviours in relation to the system. However there is a limit to the depth of analysis that can be performed on the information obtained during observation, as the evaluator does not always know why the user performed a particular action. Also with regards to the interviews it can be difficult to ask good questions, particularly to children as they may find the questions hard to understand or interpret, as well as possibly having difficulties with formulating the appropriate response.

There can be further problems with interviewing, which include satisficing where the child gives a response that appears to be acceptable, but the child has not actually thought about the question and applied their own judgement to it. This can be caused by various reasons relating to task motivation, difficulties with the task or the child’s level of cognitive abilities. Another problem is suggestibility, which “concerns the degree to which children’s encoding, storage, retrieval and reporting of events can be influenced by a range of social and psychological factors.” (Scullin and Ceci, 2001; cited by Read and MacFarlane, 2006). The effect the interviewer has on a child can be influenced by factors such as their perceived level of authority, as well as their gender and age.

With these problems in mind researchers in the Child Computer Interaction Community tend to use several survey methods (Read and MacFarlane, 2006) in order to evaluate a system. For this reason a combination of the more traditional techniques, such as observations and interviews, will be used in this project in conjunction with more recently developed techniques from the ‘Fun Toolkit’ (Read and MacFarlane, 2006), which have been specifically designed with children in mind. This will enable a more objective evaluation of the overall system to be carried out.

The various evaluation techniques that have been employed are to provide both complementary and confirmatory data, and the results gained will be used in the final chapter during the discussion of future development work. The techniques will be explained in greater depth in the following sections.

6.2.1 Observations

A group of twelve children from the year 5 and 6 classes at Jotmans Hall Primary School were observed using the tutoring system. The sample of children was chosen specifically to include a range of ability levels and language experience. Their instructions were simply to ‘complete the Numbers unit’ and their actions were noted down whilst they were using the system.
A couple of the children got confused with the initial instructions being in French which they didn’t understand, but were fine once they got onto the more detailed English instructions. Quite a few of the children were confused when there were two ‘next’ buttons on the intro screen. Even though one of these buttons was active and one was not, this was not made clear enough to be immediately obvious to the children. This is a navigation issue, to rectify this an animated arrow could be used to highlight more clearly the button the child is required to click on.

As the English instructions explained about the functionality of the system a few children clicked on the ‘menu’ button as soon as the instructional red arrow began pointing to it even though it was simply demonstrating what the button did and not actually asking the user to click on it. This is a navigation issue; the instructions would need to be made more explicit here. One child got carried away with clicking on the ‘next’ button and then realised that there was actually no way of going back to reread the instructions he had missed. This is a navigation issue; a back button could possibly be incorporated here to allow the child to go back over instructions they may have missed.

Only a couple of the children used the ‘help’ button, without it having to be pointed out to them, when they got stuck. Although once they realised what it did they would use it again unprompted on later screens, with some children using it as soon as they arrived at a new screen rather than trying to work out the instructions in French. This is a recognition issue; the ‘help’ button could possibly be made slightly larger and explained more clearly in the initial instructions to encourage the children to use it without being told.

On the first screen only one child actually clicked on the images to hear the vocabulary spoken, none of the other children realised this functionality existed. Some of the children simply studied the words whilst others skipped to the next page as quickly as possible. However the children did understand what to do after clicking on the ‘help’ and reapplying this knowledge on the additional lesson screen. This is a recognition issue; here the images need to be made to look ‘click-able’ to make it more intuitive for the child to use.

The majority of the children knew how to do the drag and drop activity immediately and had no difficulty completing it. Some of the children struggled with understanding the true or false activity as none of them had come across this vocabulary before. A few of the children worked it out by trial and error, whilst others, who were afraid of getting the wrong answer, figured it out after using the help.

The typing activity caused the most problems with the majority of the children struggling to complete it. The fact that the children couldn’t just guess at the answers meant that a lot of them got stuck on this screen, as the system wouldn’t allow them to progress until they had completed it. This is a user control issue, for this activity the children could be provided with a series of possible options to allow them to guess the answer if they are unsure.

None of the children realised they could use the footprints to go back to the previous screen to revise the vocabulary and only one of the children actually asked it was possible to go back. This is a user control issue; this needs to be made more explicit in the initial instructions.

On the frog game the numbers were in similar looking boxes as those in the drag and drop activity, this caused some children to reapply their previous experience here and try to drag the boxes onto the lily pads.
rather than clicking on them. This is a consistency issue; the boxes should be made to look different from the drag-able ones in the previous screen. A few of the children also struggled with the division as they also find this difficult in English.

It was obvious that some of the children really liked the reward at the end as they visibly smiled when the prize was displayed.

6.2.2 Interviews

Once each of the children had completed the tutoring system they were asked a series of questions about their experience, which included:

1. What did you like about the computer program?
2. What did you dislike about the computer program?
3. Is there anything you would add, change or remove?
4. Is there anything you found particularly easy or particularly hard to use?

When devising the interview questions it is important to take into account the children’s developmental stage, which in this case is concrete operational. Therefore the questions were kept relatively short and simple as they would struggle with anything that contained complex language they did not understand, that could come across as vague or ambiguous or that they had to think about hypothetically.

The children liked the majority of the activities and games including the drag and drop, true or false and frog games. Most of the children enjoyed the topic of the unit and thought overall it was a good way of teaching the numbers. Some of the children commented on the fact they liked being able to click on ‘help’ if they were stuck and also liked winning a prize at the end of the unit.

The one game most of the children disliked was the typing game because they found it hard and often couldn’t complete it. Another aspect some of them disliked was not being able to understand all of the French instructions; they would have preferred them to be in English.

There wasn’t a lot that the children would change about the system, only to possibly include more screens/activities and have the instructions in English.

The children found the hardest part of the system was remembering the numbers, particularly 6-10 and also completing the typing game. The easiest parts were the drag and drop activity, and the numbers 1-5.

6.2.3 Fun Toolkit

The FunToolkit consists of four special tools designed specifically for use with child during the evaluation process. These tools include:

- Smileyometer
- Funometer
- Again-Again
Read and MacFarlane (2006) concluded that the Smileyometer, Funometer and Again-Again evaluated essentially similar aspects, therefore for the purpose of this project the Smileyometer was chosen to be used along with the Fun Sorter.

The two year 5 children that had previously been involved as design partners in the requirements and design stages of the project took part in the Fun Toolkit evaluation session. They were told to use the Early Start and Petit Pont tutoring systems that they had looked at previously as part of the Requirements Analysis (see section 3.2.3) to help them remember what the systems were like to allow for a comparison with the new system. They were then told to complete the Numbers unit of the new tutoring system. Once all three tutoring systems had been examined they were asked to use the Smileyometer and Fun Sorter tools to evaluate their experiences of each system.

The Smileyometer is a discrete Likert scale, see Figure 6.1, and in this case was employed after use of the various tutoring systems to allow the child to apply a specific judgement score.

![Smileyometer Scale](image)

The children were asked to write on the scale where they would place each tutoring system, the completed Smileyometer can be found in the Evaluation Appendix. They rated Petit Pont as ‘Not very good’, Early Start as ‘Good’ and the new tutoring system, French Footsteps, as ‘Really good’ saying that they would rate it as ‘Brilliant’ if it was a complete system. They particularly like the reward scheme as well as the various games.

The Fun Sorter, see Figure 6.2, allows children to rank the tutoring systems from Best to Worst against various constructs. It allows the children’s opinions to be recorded, to help gain a measure of their engagement with the various systems.
The two children were then asked to fill in the Fun Sorter grid, rating each system from Best to Worst for the five categories above. The completed Fun Sorter grid can be found in the Evaluation Appendix. The children rated the new tutoring system Best for the ‘Most Fun’, ‘Learnt the Most’ and ‘I would Choose’ categories.

After the children had completed the Fun Toolkit evaluation they were asked a series of more detailed questions to get them to expand upon their initial evaluation of the new tutoring system. Their responses have been summarised below:

- The children really liked the suitcase and winning a prize at the end. They also liked the different games included in the tutoring system.
- There was nothing they particularly disliked about the system.
- They didn’t find it particularly hard to use, they only thing they found slightly difficult was remembering the numbers from screen to screen.
- They thought the content was set at about the right level as long as you had done a bit of French before.
- They felt they had learnt something from using it and had found it interesting to use but didn’t feel particularly challenged by it.
- They also felt that they had sufficient feedback, but thought that as a frog isn’t every child’s favourite animal would have liked the option to change the animal character.
- They found the interface appealing to look at and thought it was very vibrant, but said that it might not be appropriate for slightly older children who could think it was a bit childish.
- They found it fun and enjoyable to use.
- They thought the navigation was slightly confusing when there were two ‘next’ buttons on the screen, even though one of them was deactivated. They suggested an animated arrow pointing to the active one could solve this problem.

<table>
<thead>
<tr>
<th></th>
<th>Best</th>
<th>Worst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most Fun</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easiest to Use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learnt the Most</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would Choose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher would Choose</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The children came up with numerous improvements for the system which included additional rewards for completing all units such as displaying fireworks as well as being able to access more advanced vocabulary, printable worksheets and colouring pictures. The children also wanted to be able to click on the postcards on the reward screen and possibly be taken on ‘holiday’ to that place where you could learn more words. They thought it would be a good idea to have their own characters they could customise themselves. In general they would like more animation, for instance the frog’s mouth could actually move when it spoke. Further enhancements could include having different levels of difficulty and having individual accounts that the children could log into so their progress could be saved.

In addition to finding out the children’s opinions of the tutoring system the language coordinator was also consulted being considered as a key stakeholder in the project.

6.2.4 Teacher Evaluation

The language coordinator was observed using the tutoring system herself and was then asked about her opinions of the system. The results of which are summarized below:

- She thought it was a quite straightforward to use but initially struggled with how the drag and drop game worked. This was a problem none of the children had had, which she said was because they use a lot of other computer programs involving drag and drop.
- She said that the unit included two lessons worth of work, and could be used in conjunction with an interactive whiteboard so the whole class could use it at the same time.
- She thought that to reduce the difficulty the children were having with the typing task the words they need to type could be scattered around the screen so it was no longer an exercise in spelling.
- In the frog game she thought that division would be too complicated for the younger children in Key Stage 2, as well as the weaker children in the older years. She suggested it would be advisable to stick to adding and subtracting, and maybe including some additional maths problems.
- She also suggested that English instructions could be spoken aloud in the same way the French ones were.
- She said that the children often didn’t automatically click on the help button of any computer program when they got stuck, as they were used to being ‘spoon-fed’ and would rather ask the teachers than solve the problem themselves.
- Overall she liked the whole system and thought it looked really good. She could definitely see the system being used as a teaching resource.

As well as evaluating the overall usability of the tutoring system the effect the system has on a child’s learning also needs to be determined. This effect will be investigated and analysed in the next section.

6.3 Learning Evaluation

A testing process has been developed to measure the extent of the tutoring system’s influence on a child’s learning. This will involve testing a group of children before and after using the system to see if there is any difference in their test scores.
A group of twelve year 5 and 6 children were chosen to take part in the evaluation. Six children were taken from a class that had previously had a lesson on the French numbers and the other six children were taken from a class that had no previous experience of French lessons. From each class two children of low, middle and high ability were selected by the teacher to ensure choosing too many children who struggled in general with most subjects didn’t skew the results. Consequently children with severe learning difficulties such as dyslexia were excluded from the sample.

6.3.1 The Tests

Each test consisted of three activities involving spelling the numbers in French, matching the numbers to the correct French number and solving mathematical problems in French. An example test along with the correct answers to each question can be found in the Evaluation Appendix.

At the beginning of each evaluation session the purpose of the project was explained to the child as well as what was expected of them. The child was reassured that there was no pressure on their performance in the tests, that the results would only be used for the purpose of this project and they would remain anonymous.

The child was then given the first test. Once they had completed this they were told to complete the Numbers unit of the tutoring system, this was timed but there was no set time limit. At the end of the unit they were given a second test, which was in the same format as the first but with just slightly different questions.

6.3.2 The Results

Each test has a maximum possible mark of 19, with 1 mark being given per correct answer. The results are summarised in Table 6.1.
The results show that the majority of the children improved their test result after using the tutoring system, with just one child demonstrating no change and one child actually dropping marks.\textsuperscript{1}

The majority of the children scored the highest on the matching the numbers questions as they were presented with both the French and the English. They struggled most with the spelling questions, many children could spell the numbers phonetically but couldn’t remember the actual spelling. This is most probably due to the fact the children aren’t required to know the spellings in their classroom-based lessons, which concentrate on their listening and speaking skills. Most of the children left the questions blank if they felt they didn’t know the answer rather than guessing.

The average test score increase was 5.1 marks, which shows a there was a 26\% improvement in performance after using the system. See Figure 6.3.

\textsuperscript{1} It is thought that in this case the girl dropped marks due to her nervousness as she was constantly asking for reassurance that she was doing the right thing and said she was getting confused with the Spanish that she had previously learnt. It cannot however be assumed that under different circumstances her test results would definitely improve.
The average score increase for the children who had learnt the numbers previously was 7.8, which is an increase of 41%, whereas it was only 2.3 (12%) for the children that had no previous experience of French. This shows that the tutoring system could provide more benefit when used in conjunction with classroom-based learning. See Figure 6.4.

**Figure 6.3** – All Children’s Results

**Figure 6.4** – Level of French Experience Comparison
The weakest pupils seemed to benefit most from using the system with an average score increase of 6.8 (36%), the average ability children increased their scores by 5.8 (31%), whereas the highest ability children only increased their scores by 2.8 (15%). Although it is important to take into account the fact the bright children has less opportunity to excel as their test marks started off higher and therefore may have shown a greater improvement if the test was slightly more challenging or had been specifically tailored to the different abilities. See Figure 6.5. It should be noted that the results for the highest ability children were slightly skewed by F6, if her results were to be removed the increase would actually be 5.6 marks (28%), which is significantly higher and almost the same as the middle ability results.

![Figure 6.5 – Level of Ability Comparison](image)

The final comparison that was made was between boys and girls with the boys demonstrating the largest score increase of 7.2 (38%), whilst the girls on increased by 3.8 marks (20%). See Figure 6.6.

After discussing the results with the language coordinator and a secondary school French teacher it was concluded that the possible reasons for the boys doing better was although girls tend to do better in languages on average, boys can actually be the most talented scoring the highest marks. Also this learning technique may suit boys better, as girls often perform better in classroom-based learning, both orally and on paper.
The time it took the children to complete the tutoring system was also recorded to see if there was a correlation between the length of time it took them and their score increase. After analysing the results there doesn’t appear to be a relationship between the two, with the children taking the longest and shortest times getting average results, and the children getting the highest and lowest marks taking average times. See Figure 6.7.
In an ideal situation the tutoring system would have also been evaluated over a period of time to investigate whether this would again improve the test scores. There were, however, certain constraints that prevented this from being possible for the purpose of this project as time in the school was limited. Due to the possible ceiling effect of the test scores, as the second group of scores were already quite high, it was considered that this type of testing wouldn’t provide results of any further significance. To enable the system to be tested in this way the high fidelity prototype would need to be extended to include additional vocabulary as well as randomly generated questions so that the children couldn’t just memorise the position of the answers.

### 6.4 Conclusion

To conclude this chapter the various results will be assessed against the list of high-level goals, stated at the beginning of the chapter, that the evaluation process needed to investigate. The conclusion to overall project along with any future work can be found in the final chapter.

The results of the evaluation process, with respect to the high-level goals, has been summarised below:

1. **Check that the tutoring system meets the children’s expectations** –
   
The majority of the children seemed to like the system, with very few dislikes being expressed. There was nothing they would particularly change about the existing system, but they had quite a few ideas about what they would want to be added. These additions can only be expected because of it not being a fully working and complete system. The children liked the look of the interface, and found it fun, enjoyable and interesting to use.

2. **Ensure the system is suitable for children** –
   
The language coordinator thought that most of the language and content was appropriate for the children. However she did point out that they aren’t expected to be able to spell the words in French at this stage, which is probably why they all struggled with the typing task. She also suggested that the frog game would be more suitable for younger children, as well as the weakest older children, if it only involved adding and subtracting because they struggle with division in English. Both the children and language coordinator felt that the feedback provided was sufficient.

3. **Investigate the usability of the system** –
   
The children found the majority of the system relatively easy to use, but often were not prepared to help themselves if they got stuck. The ‘help’ button could possibly be made more prominent, but they cannot be forced to click on this. Once they were aware of the help facility they found this sufficient to support them through any tasks they were struggling with. The children could navigate through the unit easily, but found the intro screen slightly confusing when there were two ‘next’ buttons. Only displaying the ‘next’ button used for navigating the unit when it is active could solve this problem. The other point to note was that none of the children realised the footprints could be used to go back or even displayed a desire to be able to use this type of functionality, so it is not known if the fact this functionality wasn’t explicit enough affected the usability in any way.
4. **Investigate the effect the system has on the children’s language learning** –

Most of the children found the system challenging, particularly those that had not previously learnt any French before. Although some of the higher ability children found some of the tasks relatively easy. The majority of the children demonstrated an improvement in test scores after using the system, with it seeming to benefit most those children that had previously learnt the numbers in class, as well as also being of greater benefit to the weaker children.

It is important to note that the evaluation process can be quite subjective, due to time and resource constraints it has not been possible to entirely rule this out this situation. If more time had been available a larger number of tests could have been carried out to give a larger sample of results to be analysed. The tests could have also taken place over a period of time in a longitudinal study to find out if the children learnt more the greater number of times they used it. Finally it would have been useful to have more than one evaluator to allow one person to ask the questions whilst the other noted down the answers. This would have also allowed the observational evaluations to be more objective as one evaluator might notice something the other evaluator had missed.

Overall the evaluation process has provided a useful insight into the successes and failures of the system at this stage. It has shown the importance of testing the system out on actual users, as multiple issues occurred that were not detected during the implementation testing. The possible improvements and future work that arise as a result of this process will now be discussed in detail in the final chapter of the project.
Chapter 7

Conclusions

The primary aim of this project was to investigate second language acquisition for children at Key Stage 2 with a view to using the results of this investigation to produce a computer-based French tutoring system.

The introduction of languages into the Key Stage 2 curriculum is a very current issue. With the National Languages Strategy, developed by the Government, aiming to have modern foreign languages taught in all primary schools by 2010. During the course of this project a review of modern languages teaching has been published by Lord Dearing (2007). This review recommends that modern foreign languages should become compulsory in the Key Stage 2 curriculum but also recognises the need to provide teaching staff with the necessary support as many will have little or no language experience at all. This further supports the use of computer-based tutoring as a possible solution, particularly in light of the Government’s encouragement for primary schools to put more focus on developing children’s ICT skills. This also highlights the possibility of extending the current system to teach the teachers as well the children.

It has also been observed that now languages are no longer compulsory post-14 there has been a significant decline in the numbers of teenagers taking a modern foreign language at GCSE level. To combat this decline it is important to engage children at a younger age and to get them excited about language learning. Engaging children in language learning at a younger age also means that they are still in their ‘Critical Period’ for language learning. As discussed earlier in section 2.3.2 this ‘Critical Period’ is the widely theorised significant time in a child’s life, before they reach puberty, during which the child is better able to acquire a language to native-like levels. This suggests introducing foreign languages into the curriculum at Key Stage 2 gives children a better chance of reaching a high standard of fluency in that language.

The literature review enabled further investigation to be carried out into the areas of learning, second language acquisition, computer-assisted learning and human computer interaction.

The main findings of this investigation included, with regards to learning, the different developmental stages a child will go through, as specified by Piaget. The developmental stages allow the abilities and limitations of children of different ages to be recognised, which will in turn have an impact on the design of
the tutoring system with respect to what the potential end users will be able to cope with. In this case the concrete operational stage was focussed upon, as this covers children aged 7 to 11. Children at this stage of development can cope with hands-on problems and reversibility, which would cover aspects such as the ‘undo’ function of a system, but the children are still largely dependent on previous experiences. It is important to note that this is a generalisation and not all children will progress at the same developmental rate as is assumed here, with some children being able to cope with much more complex ideas whilst others may never reaching the later stages of development. The issues of a child’s ability developing significantly in a short space of time and the vast differences in ability between children of the same age needed to be taken into account at the design stage of this project. Therefore it was decided that as most of the children had no previous experience of foreign languages a prototype would be produced at a middle ability level.

Other important concepts of learning discussed in the literature review were ‘scaffolding’, and formats and routines, which were both developed by Bruner. Scaffolding is when an adult provides spoken support for a child during a task. There are multiple benefits of scaffolding in respect to a child’s learning and it was also seen as a technique that could easily be translated into a computer-based tutoring environment to support the child through the tasks and activities in both spoken and text-based formats. Formats and routines allow children to have new experiences from within a familiar environment, which was considered extremely useful for the computer-based tutor as it allows the child to feel comfortable because the format is consistent and therefore becomes familiar to them, with the added benefit of allowing them to quickly learn how to use the tutoring system. The child’s motivation also needs to be taken into account, of which there are two types, intrinsic and extrinsic. To motivate the child intrinsically the tutoring system has been designed in a way, which appeals to the child and includes fun activities and games, so the child will enjoy using the system. To motivate the child extrinsically the tutoring system includes a reward scheme, where the child is rewarded with a prize at the end of each unit to motivate them to complete it.

With regards to second language acquisition, an important aspect to consider was the affective filter hypothesis, which can occur because the child feels unmotivated or lacking in self-confidence and stops the child from meeting their full language potential. The tutoring system prevents this from happening as it can intrinsically and extrinsically motivate the child as well as enabling them to learn outside a classroom-based environment where they may be worried about revealing any weaknesses to other pupils. The main areas of language learning that are concentrated on at Key Stage 2 are the speaking and listening skills. Therefore it was important that the tutoring system incorporates lots of spoken language to help reinforce this.

In relation to computer-assisted learning the research carried out found that ICT is used in the majority of primary schools, with most teachers comfortable using it. This demonstrated that a computer-based tutoring system that could be used on a desktop PC would easily fit into the current primary school teaching environment. To maximise the language learning potential the computer-based tutor offers, the tutor should enable the same information to enter the child’s conceptual structures via a number of different pathways. As a result all instructions, new vocabulary and feedback are provided in both written and spoken format. The various classifications of educational software (Kemmis et al, 1977; cited by Freedman, 2006) were discussed and for this project a combination of the instructional and revelatory paradigms were used. The child is gradually presented with small amounts of fixed information as they explore various parts of the system, which ensures the child’s learning is structured but that they are also kept motivated.
Finally it was important to investigate the various human-computer interaction issues, particularly focussing on the needs of children. There are various design goals and principles that have been developed to help gauge the potential usability of an interactive system. However it was found that the majority of these goals and principles have been designed with adults in mind, with very little literature in this area specifically looking at children. One set of principles, developed by Chiasson and Gutwin (2005), does concentrate on child users and therefore these were taken into account during the development of the tutoring system.

Various child-centred design techniques were also investigated, in particular a method for involving children in the designing of a system called Cooperative Inquiry, which has been developed by Allison Druin. Techniques such as this have proved to be successful for engaging children in the design process and therefore were seen as an appropriate starting point for the design stage of this project. It is important to note, however, that very few of these techniques are underpinned by any substantial theory, such as Piaget’s developmental stages that were discussed earlier. Consequently, although these techniques seem to work well in practice, it would be interesting to further investigate the techniques in relation to the theory to see if it is possible to make the process of child-centred design even more effective.

The literature review provided valuable information relating to the development of the tutoring system, but further research needed to be carried out into the specific needs and wants of the project stakeholders to ensure the success of the overall project. This was achieved by involving the potential end users from Jotmans Hall Primary School throughout the process.

The stakeholder involvement began during the requirements gathering stage. Current teaching techniques were investigated by observing a French language lesson in a year 5/6 class and then interviewing the class teacher and a sample of pupils afterwards. From this it was discovered that the children really enjoyed the language lessons and their main motivation for learning a new language was to be able to speak it abroad. To incorporate this motivation into the system it was decided to give it a French theme, which would enable the children to directly relate to the country where the language is spoken. They also frequently used computers outside of school, so they would be already be familiar with the technology the tutoring system would run on. The class teacher suggested that the tutoring system should be visually pleasing and not too wordy, but it was found that she had little ICT knowledge and therefore was not able to expand very much on her personal requirements for the system. With this in mind the school’s language coordinator was also engaged to find out more about the school’s ICT set-up as well as her personal requirements for the system. Each class had a weekly ICT slot and all the children were familiar with using the school’s computers. With regard to the actual system she suggested that children respond best to characters and also that they should be able to repeat sections. For this reason a frog character was incorporated into the tutoring system to help guide the children through it, as well as having the functionality to go back to previous screens.

There are currently similar existing systems that help children learn French. These were also investigated to identify good and bad usability and potentially also learning aspects of each system. This investigation was carried out from two different perspectives. The first involved two year 5 children from Jotmans Hall Primary School using each of the systems and then giving feedback about what they liked, disliked and any difficulties they had. The second involved a HCI PhD student who performed an expert evaluation on each system using Nielsen’s usability heuristics. This gave a broad view of the utility of each system, and these results were then taken into consideration during the requirements specification. The interesting outcome to note here was that although the Early Start system was found to have multiple usability problems the
children themselves actually preferred it to the Petit Pont system. The reason for this was mainly due the
appealing look of the interface, which was very bright and colourful. This demonstrated the importance of
the appearance of the interface, and how children are willing to put up with a surprising number of usability
problems if the interface looks appealing to them. However there is no reason why the interface, if
carefully designed, cannot be both appealing to children as well as having good usability.

Using the results of the requirements analysis, a requirements specification was produced, which stated
each requirement, along with the justification for having that particular requirement and the place in the
project it had been sourced from. This specification then provided a basis upon which the design could be
based.

The early design process was based on the Cooperative Inquiry technique discussed earlier. The first stage,
contextual inquiry, which involves observing the children interacting with existing systems had already
been completed as part of the requirements analysis. Therefore there was no need to repeat this exercise for
the design. The second stage, participatory design, was carried out directly after the contextual inquiry
exercise as it involved the same two children, from Jotmans Hall Primary School, and allowed the children
to directly apply the ideas that had been stimulated through using the existing software. This was important
as some of these ideas may be forgotten if there was a longer period of time between the two exercises.
During the participatory design exercise the children were supplied with a selection of art materials with
which to design their interface. It was debated whether this selection should include clip art as the images
may influence the children’s ideas or they may feel constrained to only using these images. In the end it
was decided that having these images would add more benefit to the session than detriment by giving the
children a starting point if they were stuck for ideas and therefore increasing their potential creativity. The
third, and final, stage of Cooperative Inquiry is the technology immersion stage, which involves exposing
children to technologies they may not yet have come across. This stage was not considered appropriate as
the tutoring system needed to be implemented on the technology currently available in the school, and the
children were already familiar with this.

The next stage of the design involved developing some initial low fidelity prototype designs based on some
of the ideas generated by the children during the Cooperative Inquiry exercise. As the children seemed
keen on a French theme and one of their designs actually included a cartoon of a Frenchman it was decided
that both designs should be influenced by this theme in some way. Both designs also included a character
to guide the child through the system as suggested by the language coordinator and illustrated in one of the
children’s interface designs. Both children’s designs were bright and colourful so this was also conveyed
in the initial low fidelity prototypes designs.

The design process was an iterative cycle as feedback was gathered at regular intervals. Once the initial
low fidelity prototypes had been produced they were shown to the language coordinator and a group of
children, two at a time, at Jotmans Hall Primary School to find out their thoughts and ideas for the designs.
The session proved to be useful in deciding which design to expand on, as well as generating ideas for
additions and improvements to it. The two children that had previously been involved in the Contextual
Inquiry exercise proved extremely useful in this session, but the majority of the other children only
provided basic responses to the questions about each design and expanded very little on any ideas they had
to improve the designs. This shows it is beneficial to involve the children right from the start of the project
as they later demonstrate a greater understanding of the purpose of the tutoring system, which allows them
to generate more useful feedback. Although it is important to make sure that the sample chosen to
participate is an appropriate representation of the class.
The last stage was to produce the final low fidelity prototype designs based on the feedback given for the initial designs. A design was produced for each screen that would be implemented in the high fidelity prototype. These designs were then shown to the HCI PhD student, who was involved previously at the requirements stage, to obtain feedback on the potential usability issues for the designs. This was important as although the children provided valuable feedback, they tended to look mainly at the appearance of the interface and found it hard to imagine actually interacting with the system, and so were therefore not able to envisage any problems they may have with regards to this. Due to time constraints the usability issues that were discovered were corrected in the high fidelity prototype rather than producing another set of designs. Ideally the design process would have been iterated through again to gather further feedback on the final designs from the stakeholders at Jotmans Hall Primary School before implementation began.

After researching various implementation languages Macromedia Flash and ActionScript appeared to be the most appropriate for rapid prototype development and producing detailed graphical user interfaces. During the implementation stage this was found to be true as the high fidelity prototype was implemented in a matter of weeks. When the prototype was compared against the initial requirements it was found to meet all the mandatory requirements and the majority of the desirable requirements. The desirable requirements that the tutor did not completely fulfil included:

- **The tutor should offer the child different options in a task to give them an element of control in what they learn** – This was not implemented in the prototype due to the time constraints of the project, but could be incorporated into any future development.

- **There should be a variety of different tasks to suit different ability levels** – During the design stage certain constraints were specified due to the limited amount of development time available and also the fact that it was only a prototype being produced rather than a complete system. One of these constraints was that the prototype would only cater for middle ability; this requirement would be implemented in any future development.

- **It should be obvious which parts of the interface are active and which parts are not** – This requirement was considered during the design process with careful thought about how to make the active parts of the interface appear obvious to the user. This was found to be successful throughout the majority of the system, but an issue arose during the evaluation sessions, with the children not realising it was possible to click on images on the lesson screens. The children did not sufficiently explore the interface in the manner in which many adults would, so the active parts never became obvious to them. This highlights the importance of involving the users in the evaluation stage and would be rectified in future development work by making the images stand out even more and appear more ‘click-able’.

The user evaluations that were carried out on the prototype involved a specific sample of children that were chosen in order to compare various criteria such as language experience, gender and ability, and to be as representative as possible given these restrictions. The children were tested before and after using the prototype to monitor any improvement in their learning. The two written tests were based on the same format with just slightly different questions.

The tutoring system was found to be more beneficial for children that had previously done French, with a 41% improvement in their test scores, with only a 12% improvement for those who had very little or no prior experience. It also seemed more beneficial for the weaker ability children over the high ability children as well as for boys rather than girls. As only a relatively small sample was used more extensive testing would need to be carried out with a larger group of children to see if these trends continued. The

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test conditions also need to be taken into account as the actual test process could be detrimental to some children’s test scores by making them feel nervous or under pressure. This was thought to be the case for the girl who actually scored less in the second test. There is a trade-off here, as the child’s ability still needs to be tested in some way in order to monitor the impact the tutoring system has had on their learning. It is also thought that a possible reason for the increased performance by the weaker ability children over the higher ability children could be due to the latter scoring highly to begin with and therefore having less opportunity to excel in the second test, or in other words there being a potential ceiling effect. To counteract this problem the tests could be developed to include a wider range of questions to enable the more intelligent children to be sufficiently challenged and to provide adequate scope for improvement in their test scores.

In addition to the learning evaluation, usability testing was also carried out on the prototype. This involved asking the children who were taking part in the learning evaluation for their feedback on their experience of using the system as well as getting the two children who were previously involved as design partners to take part in more structured usability testing. Having a more structured set of tests allowed the prototype to be evaluated against existing systems as well as allowing for more detailed feedback to be gathered from the children.

It was found that the children preferred the new system in almost every respect over the existing systems, but they also generated a lot of ideas about possible improvements and further developments to the new system. The only problem here was the possible impartiality of the evaluation, as the children had been involved right from the beginning they had a shared sense of ownership of the system due to their part in designing it and therefore would have been less inclined to say anything negative in comparison to alternative systems. Although in this case they did back up their opinions with valid reasons so there is still a significant value in the results of the session.

The various outputs of the project can be summarised as follows:

- Findings from the literature review and the further investigation at Jotmans Hall Primary School indicate that there will be a real need for some form of support for the teaching of modern foreign languages, once they have been introduced into the Key Stage 2 curriculum. Current teaching staff often do not have any previous experience of the language they could be required to teach and therefore a computer-based solution would help aid native-like pronunciation, in addition to supporting the classroom-based teaching.

- After involving children throughout the design and development processes the benefits of child-centred design have been realised. The advantages of involving the same two children right from the beginning of the process have been discovered, as they provided much higher quality and in depth feedback than the children that were involved at only a single stage. In addition to this they demonstrated a sense of shared ownership of the system and had a greater eagerness to offer their opinions and ideas, often with very little prompting, than the other children.

- A high-fidelity prototype of the tutoring system has been produced, which provides a basis on which to develop a fully working program to be used within the Key Stage 2 modern foreign language curriculum.

- The evaluation sessions have produced empirical evidence that demonstrates the tool is particularly effective for children that have had previous classroom-based language lessons, therefore highlighting the real benefit of using a computer-based solution to support classroom teaching for modern foreign languages.
As it is only a high fidelity prototype that has so far been produced, further development would be required to turn it into a fully working product. The possible changes and additions that would be made to achieve this are discussed in the following section.

7.1 The Future

To further develop the current prototype specific areas of the system would need to be extended, which were previously omitted due to the various time and resource constraints of the project. In addition to these extensions the usability problems discovered during the evaluation stage of the project along with the suggested improvements should also be considered.

One of the constraints of the prototype was the targeted ability level, which was only for middle ability children. “There should be a variety of different tasks to suit different ability levels” was one of the unfulfilled desirable usability requirements, but in the future the teacher or pupil user could be given the option to choose from several levels of difficulty. However, there are arguments for and against this approach: for example, to enable this option to be offered additional development would include adapting some of the activities and games, for example the mathematical problem game. Some of the weaker children struggle with concepts such as division in English; therefore the easier ability levels would be restricted to basic sums for this game. Also whilst a teacher may ‘know’ a child’s ability, the child may not, so giving control to the child needs careful thought and sensitive implementation.

Even children within the same school year have been found to have significant differences in ability, whilst some children struggled during the evaluation sessions others commented that it was not challenging enough. Therefore this level would need to be set for each individual rather than basing it on a criterion as general as school year.

Another problem that was discovered relating to the different abilities of the children was with the typing activity. Some children really struggle with spelling and therefore completing the typing activity successfully was found to be impossible by some of the study participants. This causes a major problem with the system navigation as there is no way of advancing to the next screen without getting all the correct answers and therefore some children became stuck. In future development this activity would be changed and the children would be supplied with the spellings randomly positioned on the screen. This would take the emphasis of the activity away from spelling ability, which is not a requirement of the modern foreign language curriculum at Key Stage 2.

The prototype only contains a single implemented unit of language activities. For the final working system the other five units would also be implemented following the same lesson-activity-game-lesson-activity-game structure as the Numbers unit, but including different activities and games based on the topic of that unit. The prototype also currently asks the same questions for each activity/game, a random question generating functionality would need to be implemented to ensure the children do not just memorise the correct answer for each question and have actually genuinely learnt something.

There is currently no way of saving a child’s progress, in the future as the children would be using the different sections of the system on different occasions their progress would need to be saved to enable them to return to the point they previously reached. This would require the system to be linked to a database,
which would store information about each child. A login system would also need to be created to enable the children to access their individual information.

The introduction of a database would be essential to the implementation of the teacher’s area of the system. It is thought that this area would allow the teacher to set up accounts for the children and set their individual ability level. It would also allow them to monitor each child’s progress through the system and provide comparisons with the rest of the class. As this area was never planned on being implemented in the high fidelity prototype no research was carried out with respect to the requirements the teachers would have. Therefore the teachers and language coordinator would need to be consulted before the implementation of this section.

After discussions with the school’s language coordinator during the evaluation sessions at Jotmans Hall Primary School it was suggested that the system, in addition to being used on desktop PCs, could also be used in conjunction with the school’s interactive whiteboards as a class activity. This indicates that it is likely that the school will indeed adopt the software. Very little development would be needed to realise this suggestion, although it would be important to consider when developing the additional unit activities and games that they are appropriate on a class level as well as for individual use.

Although the reward scheme was liked by all the children in the future it could be extended further to include additional rewards such as unlocking different parts of the system when all units have been completed, which would further motivate the children.

One usability problem that was found during the evaluation sessions related to one of the unfulfilled desirable requirements, which stated, “It should be obvious which parts of the interface active and which parts are not”. The children did not realise that the images on the lesson screens were actually active, playing an audio file when clicked on, even though it had been carefully designed with this requirement in mind. It is not always obvious what children will do, which is why it is important to involve them in order to get empirical evidence. In response to the evidence gathered during the evaluation stage these screens would need to be modified by highlighting the images on the lesson screens to make them appear more ‘click-able’ to the children.

Another unfulfilled desirable requirement stated that “The tutor should offer the child different options in a task to give them an element of control in what they learn”. As it was only a prototype it was not possible to implement all non-essential functionality due to time constraints, but after consultation with the children at Jotmans Hall Primary School during the evaluation sessions it was discovered they would like this included in future development. The children suggested giving the user the choice of various animated characters to help support them through the tasks rather than only being able to have the frog.

7.2 Further Research

This project has also generated various research questions, which would require further investigation into a number of different areas. As the children involved during the project were all from the same age group it was not possible to make any kind of comparison relating to the evolution of a child’s language learning. Key Stage 2 covers a four-year period of a child’s education and during this time the child’s language learning ability would develop considerably. There are also individual differences in ability, interest, rate
of learning and the different facets that make up language learning from comprehension to production. It would therefore be essential to study a wide range of children, paying particular attention to the differences between the youngest and oldest children within this age group, to see if the tutoring system is flexible enough to cover all of their learning needs.

During this project it was found that the children were very enthusiastic to learn how to speak another language. This does not appear to be the case at secondary schools where more and more students are no longer continuing to study a foreign language after Key Stage 3, when it ceases to be compulsory. Hypothetically, the issue of the critical period may be a factor here, for instance the younger children may simply be finding it easier to learn another language due to still being in their critical period for language learning. This raises the question of whether learning a second language earlier, and the success a child may have at doing so, sustains their interest in later years, or if children simply become less interested in beginning language learning as they get older due to their decreased likelihood of reaching native-like levels, as well as becoming more sensitive about speaking aloud in front of their peers. Further research would need to be undertaken at secondary schools to explore this theory further and how this could affect the current modern foreign languages curriculum both at Key Stage 2 and 3.

With regards to involving children in the design stage of a project, methods such as Cooperative Inquiry could be developed further to increase the benefit the children can offer to the project. Techniques such as this have no theoretical basis, even though the appropriate theory on child development exists. There is no provision for children of different ages, which is important as younger children who do not understand abstract concepts would find the idea of designing a ‘computer interface’ on paper more difficult to comprehend than older children. Therefore the process would need to be adapted to allow younger children to generate their ideas in a more appropriate way, such as having a physical model of the computer in front of them.

After carrying out a Cooperative Inquiry exercise during the course of this project, potential changes to the process would be considered if it were to be done again. Although no adults were actually involved in this particular exercise, it is suggested in the literature that they should work alongside the children as equals. This may be a good idea in theory, but children in a school culture obey teachers and are therefore unlikely to question any idea suggested by an adult. Children and adults will never be equals because of this and the inequality of intellectual development, and therefore it is considered more of a detriment than a benefit to include adults at this stage of the design process. The literature does not suggest any specifics with regard to art supplies, but it would be important to consider the way in which the choice of materials could constrain the creativity of the idea generation involved in generating interface designs. Further research would need to be carried out into the effect that this could have on a child’s creativity, as there is a trade-off here between the chosen materials stimulating ideas that might not otherwise have been thought of, and the child feeling constrained to only thinking of ideas that the materials allow them to achieve.

The final consideration is the structure of the group during the Cooperative Inquiry exercise. In this case only two children took part, but in the future it may well be beneficial to increase this number. Warr and O’Neill (2006) state that there are various social influences that may affect the creativity of a group which include production blocking, evaluation apprehension and free riding. Cooperative Inquiry does not require any formal collaboration, but when groups of children work within the same space on the same task there is always some form of informal collaboration. Children are required to produce their own individual work, so production blocking is not an issue. Evaluation apprehension is when a child may be worried about criticism from others or as was seen during this project worrying that another child’s work is better than
theirs. This could lead to a child not following their own idea through as they might not think it is good enough in comparison to others. Free riding in this context could happen if a child is too lazy to think of their own idea and simply copying what another child is doing. Carrying out the exercise one child at a time could solve all these problems, however the trade-off here is the potential loss of creativity due to collaboration. Fischer (1999; cited by Warr and O’Neill, 2006) argues that “the unaided individual mind is highly overrated…much of our intelligence and creativity results from interaction and collaboration with other individuals”. The informal collaboration that happens between the children can help stimulate ideas that would otherwise not have been thought of. It would also be possible to minimise evaluation apprehension by forming the children into groups of similar age and ability.

As a result of this project a set of guidelines and heuristics for developing a computer-based language tutor can be specified. Although there are many documented problems with following guidelines and heuristics such as potential inflexibility and the problem with generalisation of quite specific systems, they also offer a benefit of providing a basis for any future work in this area as well as allowing others to learn from past mistakes and successes. The guidelines are as follows:

1. Engage the school’s language co-ordinator, class teachers and the children who will be using the system from the very beginning of the project.
2. Investigate the existing Modern Foreign Languages curriculum and teaching at the school.
3. Choose a cross-section of children from the target age group to act as design partners throughout the project. The number of children to be involved needs further research given the comments of problems of collaborative creativity above. Discuss the choice with the class teachers to ensure that the children who are chosen are confident and have no problems in expressing their ideas and opinions.
4. Gather requirements for the tutor from the language coordinator and class teachers, ensuring they fully understand what the end product will involve and demonstrating existing systems where appropriate.
5. Observe the children chosen as design partners interacting with existing systems in pairs and then question them about the systems to find out their thoughts and ideas. At least two evaluators should be involved, to allow one evaluator to note down all the observations and responses, leaving the other evaluator free to run the session.
6. Directly after this divide the child design partners into two groups of similar age and ability, and then provide each group with the same set of art supplies, which should include a wide range of different materials and images so as to give them as much freedom to express their ideas as is possible.
7. Set the children the task of designing an interface to teach other children a specific topic in the foreign language they are learning, taking into account the age of the group and adapting the task accordingly to ensure the children understand.
8. Produce an initial set of paper prototype interface designs for the tutor based on the findings from the previous research at the school giving various options with regards to style and appearance.
9. Show these designs to the language coordinator and class teachers to get their feedback. Also show the designs to the child design partners in pairs to find out their preferences and ideas for how they could be developed.
10. Using the initial feedback develop a full set of interface designs to show to the language coordinator, class teachers and child design partners to again gather their feedback, as well as showing the designs to a HCI expert to explore any potential usability issues.
11. Iterate through the cycle of further developing the designs and gathering feedback until all parties are happy with what has been produced.
12. Implement a high fidelity prototype of the tutor based on the designs that have been generated.
13. Involve the same people in the evaluation of the prototype tutor that were involved in the design process. It is important that both the learning and usability of the system are tested. Tests for high, middle and low ability children should be developed to test both before and after using the system, to check the effect it has had on their learning. The child design partners should also be involved in the usability testing, using evaluation tools such as the Smileyometer and Fun Sorter to allow them to compare the new system against the existing systems they have looked at previously.
14. Based on the feedback received during the evaluation process the fully working system can be developed.

The evaluation of the current prototype has generated many different ideas for future work and further research areas, but one thing is clear, the development of a fully working version of the tutoring system would fulfil a real need within the Key Stage 2 modern foreign language curriculum. The software infrastructure that has been developed could allow for any foreign language to be taught with only minor changes to the design and content of the system. Jotmans Hall Primary School have actually stated that they would adopt the tutoring system once it has been further developed into a fully working product. It is important to remember the benefit that involving children has so far brought to this project. Consequently any future development should continue in the same way to ensure the success of the final product, because as Walt Disney once said: “Our greatest natural resource is the minds of our children” and therefore their potential contribution must not be underestimated.
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Appendix A

Literature Review Appendix
Usability Goals (Preece et al, 2002)

- **Effectiveness** – refers to how good the system is at doing what it is supposed to do and if it enables the user to achieve the task they are using the system to achieve in an effective way, which in this case is learning a foreign language.

- **Efficiency** – refers to the support the system gives to the user when they are learning the foreign language and if a high level of productivity can be maintained during the learning process.

- **Safety** – refers to preventing the user making a serious error and allowing them to recover easily from any error they do make. This is particularly important with child users as they will not have the experience of knowing what actions may cause errors and also may not understand what has happened if one does occur. Another consideration is the fact that children will often click on anything just to ‘see what happens’ and may repeatedly click on interface elements if they are given feedback in the form of an animation or sound they like, even this is actually an error message.

- **Utility** – refers to whether the system actually provides the appropriate functionality to allow the user to learn a foreign language in the way in which they want to.

- **Learnability** – refers to how easy it is for the user to learn to interact with the system. The simplicity of the system is key with children who have limited IT experience, and will not want or even be able to cope with complex user manuals. Also the fact that the pupils learning should be focussed on the actual language rather than the system itself. To aid the user with learning the system it should be predictable, so they can learn as the use the system and also draw on their knowledge of the real-world and previous computer interactions to make it as familiar as possible. It also needs to be consistent otherwise the user may get confused if they are expecting an icon to be in a certain position on the interface for example.

- **Memorability** – refers to how easy it is to remember how to use the system once it has been learned and developing some kind of design interaction to support this, especially when carrying out infrequent tasks.

User Experience Goals

- Enjoyable, Fun & Entertaining – these are grouped together as they are similar goals and particularly important when trying to retain a child’s attention for an extended period of time.

- Aesthetically pleasing – if an interface is not interesting to look at for a child they will not be interested in learning how to use the system, as a child does not always see the potential future benefits of using the system, the main benefit being the learning of a foreign language. They are more concerned with the benefits to them here and now. If an interface is aesthetically pleasing a user will also be more tolerant of its usability.

- Rewarding & Motivating – a system that is rewarding to use is a motivating factor in actually using the system. Motivation is a key system goal, as a system that isn’t motivating will not allow the child to learn as much of the foreign language as they are capable of.
Usability Heuristics (Nielson et al, 2001)

- **Visibility of system status** – it is important users are always aware of what is going on with the system, particularly by giving appropriate feedback in a reasonable amount of time otherwise the user can get frustrated and not understand what the system is doing.

- **Match between system and the real world** – the system should use basic familiar language that children will understand. As stated earlier this is important to aid the usability goal of being easy to learn.

- **User control and freedom** – users should be able to get out of situations they didn’t intend to be in, particularly as children are prone to exploring a system by clicking on anything and everything. This principle supports the usability goal of being safe to use.

- **Consistency and standards** – ensuring the interface is designed in a consistent way so that interface elements always represent the same functionality and are always placed in the same area of the screen, to avoid confusion and to aid learning.

- **Help users recognise, diagnose, and recover from errors** – using simple language to describe the error and its solution, also to ensure the user doesn’t become distressed because they feel like they have done something wrong.

- **Error prevention** – even though recoverability should be built into the system the best approach is to ensure if at all possible the user is restricted from performing any action that may cause an error, which is particularly important in the case of children who have limited experience and may be frequently performing incorrect actions.

- **Recognition rather than recall** – increasing visibility of interface elements to aid learning to use the system and remembering how to use it once learnt.

- **Flexibility and efficiency of use** – this involves providing hidden shortcuts to enable expert users to perform tasks more quickly, which isn’t as relevant in the case of children because most will be novice users.

- **Aesthetic and minimalist design** – avoiding irrelevant information that could distract the user from the task at hand. The interface needs to be aesthetically pleasing as stated previously but not to the extent that it takes focus away from the actual learning of the foreign language as children are easily distractible.

- **Help and Documentation** – providing a set of instructions on how to use the system that can be easily followed by a novice user and doesn’t go into too much detail. It is more important that the interface is instinctive rather than having to read pages of information to get it to work, as children won’t be able to take all of it in.

Interaction Design Styles (Dix et al, 2004)

The following interaction styles are presently not often used and would not be suitable for inexperienced child users:

- **Command Line Interfaces** – these use a series of single characters, abbreviations, function keys and whole-word commands to directly instruct the computer.

- **Menus** – these are a set of options that are displayed on the screen and can be selected by the user using the mouse or keyboard.

- **Natural Language** – this uses instructions that are expressed in everyday words.

- **Question/Answer Dialog** – this is where a user provides input commands to the system via a series of questions that takes place in a specific domain.
The following interaction styles are a lot more commonly used and also more appropriate for the novice user:

- **WIMP Interface** – WIMP stands for Windows, Icons, Mice and Pull-down menus, which are all features of this windowing system. It is used in the majority of interactive systems and would particularly appeal to child users as pictures can be used to replace text commands making the whole thing easier and more appealing to use. Two variations of the WIMP interface are:
  - **Point-and-click interfaces** – this interface allows nearly all interactions to take place by just a single click of the mouse. The advantages of which are it is a lot simpler to use and allows other interaction techniques to be used such as a touch screen, which would make a child feel more involved in a system. As the child users would be at the concrete operational stage, as previously stated, they are able to solve hands-on problems, which the touch screen would facilitate, whereas manipulating the system using other methods often involves more abstract concepts that some users may struggle with. The slight disadvantage of this type of interface is it could take slightly longer to perform complex actions, as multiple parameters cannot be specified at the same time. Although as the system is aimed at children it shouldn’t involve too many complex tasks.
  - **Three-dimensional interfaces** – this can involve anything from simply giving the WIMP elements a 3D appearance to creating an entire 3D workspace. The advantages of this is it gives you extra space as when you move around the screen as objects get smaller when you move away from them. This is more natural way of increasing space than iconizing the windows. It also encourages users to apply real-world knowledge and experience to interacting with the system, which makes the whole thing easier to learn especially for children who may be struggling with the more abstract concepts a computerised system often presents to them.

**Educational Design Principles** (Najjar, 1998)

2. *Use the medium that best communicates the information* – for example sound is best used for when small amounts of information needs to be remembered over a short period of time, whereas if the information needs to be retained over a longer period then text is the better medium to use. It is important to note that the use of sound is not always appropriate within a classroom setting, so would need to be incorporated carefully. In the case of the computer-based tutor the age of the child also needs to be taken into account when choosing the medium, as the child may not be able to cope with vast amounts of text. One solution to this problem would be to use both text and auditory mediums simultaneously, for instance if the child cannot read a specific word then hearing it spoken aloud may aid their understanding. Pictures can also be used to increase the child’s understanding of the text, although it is important to note that using pictures that are conceptually similar or when expressing abstract concepts may cause confusion for the child.

3. *Use multimedia in a supportive, not a decorative way* – this extends the previous idea of using two mediums together such as text and sound. The audio supports the text and improves the learning performance of the child by helping them understand words they may not yet be able to read. Supportive illustrations can also be used and are often a motivating factor for the child, but pictures shouldn’t just be used to make the interface appeal more to the child as using unrelated illustrations could actually decrease learning.
4. *Make the user interface interactive* – Fowler (1980; cited by Najjar, 1998) states that interaction is mutual action between the learner, the learning system, and the learning material. Interactivity allows the learner to have more control over the system, which therefore gives the child control over their own learning. To help integrate the material the tutor should periodically ask the child questions about what has been looked at. Interactivity is associated with increased learning performances and helps the child to better retain the knowledge they gain from the tutor over a period of time as it requires the child to interact with the system, ensuring they are actively taking part rather than using it passively. This in turn will help the child to have a better attitude towards learning and become more motivated.

5. *Present educational multimedia to motivated learners* – this is not a question of only allowing those children in the class that are motivated to learn to use the computer-based tutor, but trying to use the multimedia in a way which ensures all children become motivated in their learning. Intrinsic motivation, which was discussed in an earlier section, improves learning. To improve a child’s intrinsic motivation the content of the tutor could relate to their interests and hobbies, and also instructions written in a personal style could be used rather than a formal way makes a task seem more fun. A further way of motivating is to provide praise after a child completes a task as well as informative feedback to help them understand where they went wrong. Multimedia material itself can initially provide motivation because of its novelty value, although it is important to incorporate other factors as this can fade over time.

6. *Use multimedia to focus the learner’s attention* – this highlights the relevant information to the child, which will improve their learning performance. For example it could be used as a filter or as a way of discriminating information for the child. It is important that the multimedia does not direct the learner to unrelated information as a child could find this distracting.

7. *Encourage learners to actively process the information* – incorporating processing tasks into the tutor will encourage the child to become an active learner by integrating the information they are studying. These tasks could include forcing the learner to figure out confusing information or periodically asking them questions. This should improve learning as long as the task difficulty is set at the right level for the child otherwise the danger is the child will become discouraged by their confusion.
Appendix B

Requirements Appendix
CALL Evaluation Checklist

The following list of questions is taken from a checklist specified by Chambers et al (2006). An evaluation checklist provides a framework for evaluating a system and enables each system to be assessed in an ordered and structured way. Using the same checklist for each system also provides a clear comparison between the two.

1. **Does the software provoke and maintain student interest to a satisfactory degree?**
   (Which is related to how likely it is that the information will be retained.)
   
   Petit Pont:
   When tested out on two ten year old pupils they found the people and tasks interesting as long as they understood them, but became impatient when they had to wait for some screens to load.
   
   Early Start:
   They found most of the tasks interesting, except for one which they didn’t understand. Sometimes seemed distracted during the videos as they seemed a little repetitive.

2. **How is new language introduced? Is sufficient (optional) practice possible before learners produce language?**

   Petit Pont:
   New language is introduced in a spoken format, which is controlled by the user clicking on various parts of the interface so they can repeatedly hear each new word as many times as necessary.
   
   Early Start:
   New language is introduced in a spoken format through videos and games using images rather than text to support each word. Each word is repeated several times to consolidate the child’s learning and they can play several games to practice the vocabulary before actually speaking it themselves. This will give the child more confidence when they do come to speak the language aloud themselves.

40. **Does the software make optimal use of the writing medium?**

   Petit Pont:
   Minimal written language is used although some activities test the child’s reading ability of the foreign language. The labels for the navigational tools are in English, but everything relating to the activity is in French including the instructions.
Early Start:
The software uses predominantly spoken French language with simple French words introduced later on. This is appropriate for children aged 7 to 11 as they often find listening easier than reading.

41. Does the software attempt to create a target language context?

Petit Pont:
The software uses French names for the characters and the setting for the activities is designed to look like a French town, although there is no other reference or explanation about the culture.

Early Start:
The videos show French children taking part in typical French activities, which helps give the users a taste of the French culture.

42. Is there sufficient aesthetic appeal (colour, layout, legibility, style of presentation)?

Petit Pont:
The interface is very colourful and uses different shapes, which will appeal to children. The background tends to be a bit cluttered which means the navigational icons don’t stand out as much. The text is quite clear and easy to read. The overall presentation style is fun, but would probably be better if it was more minimalist.

Early Start:
The interface will look very appealing to children as it is very colourful, has a clear and consistent layout. It also uses large clear text, which makes it easy to read, and is presented in a fun style.

43. Does the software perpetuate cultural stereotypes, i.e., how objective is the content?

Petit Pont:
As the software doesn’t incorporate much cultural information, there is no issue with cultural stereotypes.

Early Start:
The system incorporates traditional cultural activities to illustrate different aspects of the language, which at times can be a somewhat generalised view of the French culture. Although it is also important to take into account the information does need to be simplified for children.
44. How current is the content?

Petit Pont:
The system matches both the QCA Guidelines for Modern Foreign Languages at Key Stage 2 and the Modern Foreign Language Framework for Key Stage 2.

Early Start:
The system matches the current QCA Guidelines for Modern Foreign Languages at Key Stage 2.

45. Does the software incorporate suitable language-learning activities and offer scope for additional activities away from the computer?

Petit Pont:
The system includes various activities to consolidate each unit of work, as well as a chance to practice oral skills and play a related game. Other materials are provided to link in with the software such as an audio CD and flashcards, which could be used in a classroom environment.

Early Start:
The system includes numerous activities and games as part of each section that directly relates to what the child has just been taught. Additional worksheets are also provided that can be printed out and used within the classroom environment.

46. Does the software cater for all type of learners?

Petit Pont:
There is no option to change the level of the material being presented but activities can be repeated until the child is happy with what they have learnt.

Early Start:
The level of the software is not able to be altered, but it does allow for the child to repeat any part that they may be struggling with as many times as necessary.

47. What form of (self-)assessment, learner feedback or profiling is provided?

Petit Pont:
Feedback for each activity is given in spoken French, although this doesn’t always include providing the child with the correct answer. A score for each activity is also saved for the individual child and they can also review their previous scores.

Early Start:
For each interactive activity the child is provided with a visual representation of their progress for example a numerical score. Also some activities provide spoken corrections for incorrect
input whereas others provide an audio sound effect to represent an incorrect answer and allow the child another attempt. This could become frustrating for them if they cannot find the correct answer.

48. Is the multimedia dimension exploited with regard to grammar and language patterns?

Petit Pont:
The program allows the child to practise having a conversation by recording their own voice, as well as using visual aids such as gradually revealing text and using different colours to help them understand how this is structured.

Early Start:
No, the program concentrates more on individual vocabulary.

49. How are language items presented on screen to the learner and can the learner control the order of their presentation?

Petit Pont:
The language items are broken up into units, but the child has control over which order they complete the activities in and whether they learn new vocabulary, practise their spoken language or play a language-related game.

Early Start:
The language items are presented to the child in an appropriate order within each section, although the user is able to choose which section to look at and can skip individual parts of the section.

50. How clear are the instructions for users?

Petit Pont:
The instructions for each activity are in French, so the child is expected to try and figure out what is expected of them, which may cause them to become confused.

Early Start:
The goal of each section is stated clearly at the beginning of the section, so the child is aware of what they are supposed to achieve. The written instructions use simple language and are written in English to make it easy for the child to understand. They are also spoken in French to help the child become familiar with the vocabulary associated with the particular topic they are learning about.
51. What support for teachers is provided?

Petit Pont:
Technical help is provided on the website, as well as a contact email if the problems still cannot be solved. Written guides are also available for specialist and non-specialist teachers to help them.

Early Start:
A teacher’s manual is provided containing all the vocabulary for each section as well as the relevant activities. The Early Start website also provides an online teacher’s manual with additional information about each section and a technical FAQ section. This is sufficient as the system itself is quite straightforward to use and there is a telephone help line for any problems that cannot be solved using the manual or the website.

Screenshots of Existing Screens

EARLY START

Main Menu
You'll name colours in French, be able to play some French games, and know about Matisse, the artist.

Just click on to move through the section. Click on if you ever want to go back.
Have you really finished with Early Start CD 1?

Yes - QUIT Now  NO - Go back to MENU

Exit Confirmation Message
PETIT PONT

Welcome to the World of Petit Pont

This is a Demo CD-ROM containing a working example of the Pupil's Interactive CD-ROM (Network Version, Interactive Whiteboard Version also available) as well as samples from the other components of Petit Pont.

You can purchase any electronic component, or the special packs:
Pupil's book + CD-ROM single user,
Teacher's Guide + Copymaster/Flashcards CD-ROM + Audio CD
FREE of charge, using your e-learning credits from COL

For further information contact Eclipse Books on 0870 242 22 69
or email sales@eclipsebooks.com, or visit

Main Menu

Choose a Unit

Unit Menu
Activity 6 Screen

Activity 7 Screen
Appendix C

Design Appendix
Lesson Plans

Lesson Plans and Ideas.

These plans have been written on the basis of teaching a 5-minute slot every day, with the ongoing support of the DVD/video material. It will probably take 2-3 weeks to cover a unit (depending on the amount of vocabulary involved), which works out as roughly two topics per term.

I suggest you alternate between watching the DVD support and playing a game, e.g.:
Monday - DVD (several times to get the hang of pronunciation.)
Tuesday - game to reinforce new vocabulary
Wednesday - game
Thursday - repeat DVD and repeat a game
Friday - game

All of this will depend upon how quickly your children pick up new things; they may be ready to move on, or need more time.

Topics such as colours that have a lot of new vocabulary may need to be taught in several sections, as there are up to 12 new words to remember, and a lot of reinforcement games will be needed. You may want to do the 1st 6 colours, then another topic, and then come back to revise the 1st 6 and learn the next 6.

Remember to limit new vocabulary to 2 or 3 words in a session; once children are used to the language they may be ready to cover more than that, but you can guarantee they will forget lots of things, too!

Most importantly: ALWAYS go over the top with praise, and the children will rise to it.

Have fun!
Useful words and phrases:
These are based on the scheme and the terms that the children are most likely to meet in Year 7. There are other phrases that mean the same, which the children may know also.

**Praise**

<table>
<thead>
<tr>
<th>French</th>
<th>Phonetic</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>OK</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Bien</td>
<td>Bee-an</td>
<td>Good</td>
</tr>
<tr>
<td>Très bien</td>
<td>Troy bee-an</td>
<td>Very good</td>
</tr>
<tr>
<td>Super!</td>
<td>Soo-pair</td>
<td>Super (v. v. good)</td>
</tr>
<tr>
<td>Excellent!</td>
<td>Ex-say-lon</td>
<td>Excellent</td>
</tr>
</tbody>
</table>

**Classroom Instructions (unit 16)**

<table>
<thead>
<tr>
<th>French</th>
<th>Phonetic</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donnez-moi cinq</td>
<td>Don-nay-mwa sank</td>
<td>Give me 5</td>
</tr>
<tr>
<td>Asseyez-vous</td>
<td>A-soy-yay voo</td>
<td>Sit down</td>
</tr>
<tr>
<td>Dépêchez-vous</td>
<td>Duh-pe-cahy voo</td>
<td>Hurry up</td>
</tr>
<tr>
<td>Installez-vous</td>
<td>An-stor-lay voo</td>
<td>Sit and get ready</td>
</tr>
<tr>
<td>Préparez-vous</td>
<td>Pre-par-ay voo</td>
<td>Get ready</td>
</tr>
<tr>
<td>Silence</td>
<td>See-jons</td>
<td>Quiet</td>
</tr>
</tbody>
</table>

**Greetings (See units 1-3)**

<table>
<thead>
<tr>
<th>French</th>
<th>Phonetic</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonjour</td>
<td>Bon-jure</td>
<td>Good day</td>
</tr>
<tr>
<td>Bon nuit</td>
<td>Bon Nwee</td>
<td>Good night</td>
</tr>
<tr>
<td>Salut</td>
<td>Sa-loo</td>
<td>Hello/hi</td>
</tr>
<tr>
<td>Merci</td>
<td>Mare-see</td>
<td>Thank you</td>
</tr>
<tr>
<td>S’il vous plaît</td>
<td>Si voo play</td>
<td>Please</td>
</tr>
<tr>
<td>Au revoir</td>
<td>O re-vwar</td>
<td>goodbye</td>
</tr>
</tbody>
</table>
Objective: To learn the numbers 1 - 10.
Resources: Number cards; number line/100 square

- Watch DVD lesson 6. N.B. This lesson goes up to 12, so that all children can say their age up to Year 7, for later lessons. It's up to you if you want to do them.
- Hold up the number cards and repeat the names (on the back of the cards). The children can repeat them after you. Start with 1 - 5.
- Make a number line out of children and read it out with the class several times, together.
- Go around the class, calling out 1 - 5 in turn. How quickly can they go around the whole class?
- Allocate odd numbers to one half of the class and even numbers to the other. (Could split them girl/boy - filles garçons gar-son). Call out a number from 1 - 5 and the children have to stand up if they hear their number.
- If time, let the children choose a number and write it down on a white board or scrap of paper. They have to hold it up when it is called out.
- Hold up the number cards and see how many children can remember the names from last week. Correct pronunciation.
- Hold up the numbers in different orders and the class can say them together.
- Let the children get into their circles and use the enablers to go around in turn, saying a number from 1 - 5. When they reach 5, they start again if they have not been all the way around the circle.
- Try a Mexican wave, if you have lots of number cards. The children hold up the numbers in turn and say them until you have been all the way around the class. You may need to explain what a Mexican wave is!
- Play the game on the video, outside if possible. Call out numbers and the children have to form groups of that number of children.
- Repeat the games with the number 6 - 10 (12) when you think the children are ready.
- Play Noughts and crosses to finish. Make the boys (garçons) one thing and the girls (filles) another. Draw a noughts and crosses grid on the board, but fill the spaces with numbers from 1 - 10. The garçons and filles takes turns in giving you a number which you convert into a nought or a cross. They will play this for hours and it doesn't matter if they call out answers to help each other, because it means they are practising the vocabulary.
- See also p.57 - 61 in the folder for more games and songs.
Participatory Design Interface – Child A
Participatory Design Interface – Child B

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Childrens’ explanations of interface designs

Child A –
The different pictures are used to illustrate the colours along with the French word. If you click on the people having a conversation it would take you to a new page. On this page the computer would type a question in French and then you would type the answer. It would then give you a score depending on whether you typed the correct answer or not. The blue square contains the menu and you can click on each word to go to a different section of the system. ‘Beginner’ means there will be no hard words. ‘Advanced’ means the words will be of an intermediate level. ‘Expert’ means it will be harder and there will be tasks that teach you how to say ‘I am…’ in French as well as different animals. ‘Games & Downloads’ would allow you to download games to help you learn French, such as bingo, onto your computer. ‘Worksheets’ will allow you to print off worksheets to complete in class. In the bottom right hand corner ‘Click here to become a member’ allows you to send your ideas to the designer of the system so they could incorporate them into the system such as a new design of a page or a new game.

Child B –
The animals represent each of the different colours and each one is connected to its own character such as ‘Mr Rouge’. You can click on the button underneath each picture, which will take you to another screen. On this screen if you manage to find the character in the crowd it will tell you more about that colour. There is an assistant called ‘Mr Light’ in the top right hand corner which you can click on to get more help or information. The red box in the middle is the menu and you can click on each word to go to a different section of the system. ‘New Learner’ will teach you greetings and simple words. ‘Advanced’ will teach you harder words. ‘Video Activities’ will be like the videos on the science section of the BBC website and you will complete a task based on the video you have watched. ‘Fun and Games’ will involve games such as ‘Kick the Football’ where you have different squares with numbers in and you have to type the numbers in French. ‘Worksheets’ will allow you to print off worksheets to complete in class. ‘Downloads’ allows you to download wallpaper, pictures and videos relating to French. ‘Greetings’ allow you to learn French greetings. ‘Translator’ involves a character called ‘Mr French’ where you can type in the English word into a speech bubble to be translated and you can click on ‘Mr French’ to get the correct pronunciation.
Initial Low Fidelity Designs

Design 1 – Main Menu

Design 1 – Unit Screen
Design 2 – Main Menu

Design 2 – Unit Screen

Unit 1: Numbers

1 = un
2 = deux
3 = trois
4 = quatre
5 = cinq

Practise counting to 5
Final Low Fidelity Prototype Designs

Final Design – Main Menu

Final Design – Reward Screen
Final Design – Lesson Screen 1

Final Design – Drag and Drop Activity Screen 1
Final Design – Typing Activity Screen

Final Design – Mathematical Problem Game
Network Diagram – Low Fidelity System Structure

Red arrow indicates expected route through the system.
Appendix D

Implementation Appendix
Red arrow indicates expected route through the system.
High Fidelity Prototype Screenshots

**Main Menu**

**Reward Screen**
Bienvenue dans l’Unité 3!

D’abord les chiffres de 1 à 5...

1 = Un
2 = Deux
3 = Trois
4 = Quatre
5 = Cinq
Drag and Drop Activity Screen

True or False Game Screen
Lesson Screen 2

Typing Activity
Mathematical Problem Solving Game

End Screen
## Black Box Testing Results

<table>
<thead>
<tr>
<th>Test No.</th>
<th>Test Description</th>
<th>Expected Result</th>
<th>Actual Result</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Launch tutoring system via web.</td>
<td>Main menu screen to be displayed.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>2</td>
<td>Click button to view suitcase.</td>
<td>Suitcase to be displayed, with Numbers souvenir place empty.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>3</td>
<td>Click on footprint button to begin Numbers unit.</td>
<td>On mouse roll over the button should change to red and on click go to intro screen of Numbers unit.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>4</td>
<td>Click on Next button in centre of screen.</td>
<td>All frames of the intro screen to be displayed.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>5</td>
<td>Click on Next button in bottom right hand corner of screen.</td>
<td>Numbers 1 to 5 lesson screen to be displayed.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>6</td>
<td>Click on Help button.</td>
<td>Help text to be displayed in speech bubble.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>7</td>
<td>Click on images 1 to 5.</td>
<td>Corresponding audio to be played.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>8</td>
<td>Click on Next button.</td>
<td>Drag and drop activity screen to be displayed.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>9</td>
<td>Click on Help button.</td>
<td>Help text to be displayed in speech bubble.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>10</td>
<td>Drag ‘Un’ box and drop onto target area next to the cake images.</td>
<td>Box to spring back to original position after release.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>11</td>
<td>Drag ‘Un’ box and drop onto target area next to hotdog image.</td>
<td>Box to stay in dropped position after release.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>12</td>
<td>Click on Next button after completion of activity.</td>
<td>True or false game screen to be displayed.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>13</td>
<td>Click on Help button.</td>
<td>Help text to be displayed in speech bubble.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>14</td>
<td>Click on ‘Faux’ button.</td>
<td>Feedback for a correct answer to be given and frog 1 to be animated.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
<tr>
<td>Step</td>
<td>Action</td>
<td>Expected Feedback</td>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>--------</td>
<td>--------------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Click on Next and then ‘Faux’ button.</td>
<td>Feedback for a wrong answer to be given.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Click on Next and then ‘Vrai’ button.</td>
<td>Feedback for a correct answer to be given and frog 3 to be animated.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Click on Next &gt; Faux &gt; Next &gt; Faux &gt; Next buttons.</td>
<td>Score to be displayed as 4/5 and the Next button to be activated.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Click on Next button.</td>
<td>Numbers 6 to 10 lesson to be displayed.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>Click on Help button.</td>
<td>Help text to be displayed in speech bubble.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Click on images 6 to 10.</td>
<td>Corresponding audio to be played.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Click on Next button.</td>
<td>Typing activity screen to be displayed.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>Click on Help button.</td>
<td>Help text to be displayed in speech bubble.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Type the following in the input boxes: “six”, “sept”, “huit”, “neuf”, “dex”.</td>
<td>The following feedback to be displayed: “Oui”, “Oui”, “Oui”, “Oui”, “Non”.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Delete “dex” and instead type “dix”.</td>
<td>Feedback for all correct answers to be given and the Next button to be activated.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Click on Next button.</td>
<td>Mathematical problem solving game to be displayed.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>Click on ‘Un’ button.</td>
<td>Incorrect answer feedback to be given and frog audio to be played.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Click on ‘Trois’ button.</td>
<td>Correct answer feedback to be given and frog animation to hop to next lily pad.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Click Next button after completing activity.</td>
<td>End screen to be displayed.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>Click Next button in centre of screen.</td>
<td>Prize souvenir to be presented and then appear in suitcase.</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Click Next button in bottom right hand corner</td>
<td>Main menu to be displayed with all footsteps coloured</td>
<td>As expected. PASS</td>
<td></td>
</tr>
<tr>
<td></td>
<td>of screen.</td>
<td>in green.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>31</td>
<td>Click button to view suitcase.</td>
<td>Suitcase to be displayed as completely full.</td>
<td>As expected.</td>
<td>PASS</td>
</tr>
</tbody>
</table>
Black Box Testing Route

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Appendix E

Evaluation Appendix
**Smileyometer Results**

- P.P. = Petit Pont
- E.S. = Early Start
- F.F. = French Footsteps (new system)
### Fun-Sorter Results

<table>
<thead>
<tr>
<th></th>
<th>Best</th>
<th>Worst</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Most Fun</strong></td>
<td>F.F.</td>
<td>E.S.</td>
</tr>
<tr>
<td><strong>Easiest to Use</strong></td>
<td>P.P.</td>
<td>E.S.</td>
</tr>
<tr>
<td><strong>Learnt the Most</strong></td>
<td>F.F.</td>
<td>E.S.</td>
</tr>
<tr>
<td><strong>I would Choose</strong></td>
<td>F.F.</td>
<td>E.S.</td>
</tr>
<tr>
<td><strong>Teacher would Choose</strong></td>
<td>E.S.</td>
<td>F.F.</td>
</tr>
</tbody>
</table>

*P.P. = Petit Pont*

*E.S. = Early Start*

*F.F. = French Footsteps (new system)*
Learning Evaluation Tests

**Example Before Test**
Correct Answers in Red

**Spelling**

Write the number in French. The first one has been done for you as an example.

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>French Spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td><em>Un</em></td>
</tr>
<tr>
<td>Five</td>
<td><em>Cinq</em></td>
</tr>
<tr>
<td>Three</td>
<td><em>Trois</em></td>
</tr>
<tr>
<td>Ten</td>
<td><em>Dix</em></td>
</tr>
<tr>
<td>Eight</td>
<td><em>Huit</em></td>
</tr>
<tr>
<td>Two</td>
<td><em>Deux</em></td>
</tr>
</tbody>
</table>
Matching words and numbers

Draw a line to connect the number with the correct French spelling. The first one has been done for you as an example.
Maths

Solve the following maths problems. The first one has been done for you as an example.

\[\text{un + deux} = 3\]

\[\text{un + trois} = 4\]

\[\text{deux x quatre} = 8\]

\[\text{dix – cinq} = 5\]

\[\text{neuf / trois} = 3\]

\[\text{six + un} = 7\]
**Spelling**

Write the number in French. The first one has been done for you as an example.

<table>
<thead>
<tr>
<th>NUMBER</th>
<th>French Spelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>Un</td>
</tr>
<tr>
<td>Nine</td>
<td>Neuf</td>
</tr>
<tr>
<td>Four</td>
<td>Quatre</td>
</tr>
<tr>
<td>Six</td>
<td>Six</td>
</tr>
<tr>
<td>Seven</td>
<td>Sept</td>
</tr>
<tr>
<td>Ten</td>
<td>Dix</td>
</tr>
</tbody>
</table>
Matching words and numbers

Draw a line to connect the number with the correct French spelling. The first one has been done for you as an example.
Maths

Solve the following maths problems. The first one has been done for you as an example.

un + deux = 3

deu + cinq = 7

trois x trois = 9

neuf – quatre = 5

huit / deux = 4

sept + un = 8
Ethics Form

UNIVERSITY OF BATH

Department of Computer Science

13-POINT ETHICS CHECK LIST

This document describes the 13 issues that need to be considered carefully before students or staff involve other people ("participants") for the collection of information as part of their project or research.

1. **Have you prepared a briefing script for volunteers?**
   I will explain the purpose of my project and then explain the simple evaluation procedure that they will be required to follow.

2. **Will the participants be using any non-standard hardware?**
   No, they will be using the desktop computers at the school.

3. **Is there any intentional deception of the participants?**
   No.

4. **How will participants voluntarily give consent?**
   The school will give consent on behalf of the participants, but the work is not intended to be used outside the scope of the project.

5. **Will the participants be exposed to any risks greater than those encountered in their normal work life?**
   No.

6. **Are you offering any incentive to the participants?**
   No.

7. **Are any of your participants under the age of 16?**
   Yes, consent will be given by the school on their behalf.

8. **Do any of your participants have an impairment that will limit their understanding or communication?**
   No.

9. **Are you in a position of authority or influence over any of your participants?**
   Yes, although I will not be using my authority to force them to do anything against their will.

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10. **Will the participants be informed that they could withdraw at any time?**
   Yes, if the participants become uncomfortable they will be able to stop the evaluation at any time.

11. **Will the participants be informed of your contact details?**
   Yes the school will be provided with my email address and also the name and email address of my project supervisor.

12. **Will participants be de-briefed?**
   Yes, I will explain what I intend to do with the data that I have collected from the evaluation and will send the school a copy of my final project dissertation.

13. **Will the data collected from the participants be stored in an anonymous form?**
   Yes, the participants will be referred to under a different name.

---

**NAME:** Laura Benton

**SUPERVISOR (IF APPLICABLE):** Hilary Johnson

**SECOND READER (IF APPLICABLE):**

**PROJECT TITLE:** An Investigation into Second Language Acquisition and Tutoring Systems at Key Stage 2

**DATE:** 26 March 2007