The Blobz Guide to Electric Circuits: An Interactive Learning Tool to Aid In The Teaching of Key Stage 2 Science

Andrew Thelwell

Staffordshire University

Abstract

Technology is changing the way children live and learn (Druin, 1999), but computer-based learning for children is still a relatively new phenomenon. For this reason, many of the products currently available are “based on pure folklore about the way kids supposedly behave”, rather than actual research (Gilutz & Nielsen, 2002). This project aims to tackle this problem by creating a computer-assisted learning (CAL) package that is appealing to the target audience, suitable for its purpose, and effective as a learning tool, through research into the psychology of learning and the appraisal of all relevant design issues, especially those specific to designing for children.

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A Brief Account of Educational Computing

Computing and education are two fields with links that go back as long as forty years or more (Alessi & Trollip, 2001). During this period, changes have come about in both of these fields, but the magnitude of change in each field varies somewhat. Educators have moved from the ‘old’ behaviourist way of thinking to the newer (and now more widely accepted) constructivist approach. However, the change in the overall process of teaching is rather limited, particularly when compared to the changes that have occurred in technology (and particularly computing) during the same time period. Ferguson (2001, p.46) argues that “the process of teaching has remained largely unchanged in the last 100 years”. The evolutionary changes in computing and technology are far more obvious, however.

During the 1960s and 1970s, the vast majority of instructional computing took place on huge mainframe computers; it would have been restricted almost exclusively to universities, and would have consisted of little more than typing text. From the late 1970s onwards, things began to change. In 1978 came the Apple II, the first widely available *microcomputer* (Alessi & Trollip, 2001). In the decade after the launch of the Apple II the IBM Personal Computer and the Apple Macintosh were released. In the subsequent quarter century, microcomputers have developed enormously.

Today, home computers are thousands of times more powerful than their early ancestors were. They are able to display realistic video, graphics and animations and can play vivid sound and music in stereo, quadraphonic and even full digital surround sound. Coupled with the increase in technological ability has been a steady fall in cost. For the consumer, this creates a whole host of opportunities to indulge in the computing environment at a relatively low cost—games, movies, music, art and design, mathematics, business, communications and, of course, education are all now available to the computer user with great ease

More and more, then, computers have become a part of everyday life, including the lives of children (Druin, 1999). Children now take Information & Communication Technology (ICT) lessons as a compulsory part of their standard education, but computers have also become a tool in their own right, just as useful in an lesson as a blackboard, a textbook or a calculator. Computer software can be used to teach children now more than ever because the technology is increasingly accessible, and children are becoming increasingly comfortable using the technology on a day-to-day basis.

A problem still remains, however. As the kids are becoming increasingly 'tech-savvy', the technology appears to be failing to reciprocate by becoming equally 'kid-savvy'. Many of the software packages, the systems, the websites that exist (even many of those aimed specifically at kids) are simply not child-friendly. Because this new 'accessible-to-all' computer based learning is still a relatively new phenomenon, many of the products currently available are "based on pure folklore about the way kids supposedly behave", rather than actual research (Gilutz & Nielsen, 2002).

Aims of This Project

This project aims to tackle the aforementioned problem head-on. The goal is to create a computer-assisted learning (CAL) package to support an area of the United Kingdom's National Curriculum. In order to tackle the problem, the aim of this project is to create an artefact that is appealing to the target audience, suitable for its purpose, and effective as a learning tool, through research into the psychology of learning and the appraisal of all relevant design issues, especially those specific to designing for children. The aim is also to create an artefact that, while having enough rich content to satisfy the target audience, is deliverable over the web. In addition, the final artefact is required to conform to the requirements laid out by the NGfL

About the NGfL and the National Curriculum

The National Grid for Learning (NGfL) is the gateway to educational resources on the Internet. It provides a network of selected links to web sites that offer high quality content and information, and is the national focal point for learning on the Internet. The NGfL is the largest educational portal in Europe, and all sites that are included in the NGfL have to follow a set of ground rules; any designer wishing to act as a content provider is required to sign up to the NGfL Code of Conduct. This means that all NGfL sites have achieved a certain level of quality, which is indicated through the awarding and display of the NGfL logo. This logo acts as a badge to show users that the web site they are accessing is a trusted site of educational value.

The National Curriculum for England is a standard laid out by the government to define the content of what is taught in schools to children of compulsory school age (five to sixteen years). According to *The National Curriculum for England Online* (Department for Education and Skills [DfES] & Qualifications and Curriculum Authority [QCA], 1999):

> The National Curriculum sets out a clear, full and statutory entitlement to learning for all pupils. It determines the content of what will be taught, and sets attainment targets for learning. It also determines how performance will be assessed and reported. . . . It allows schools to meet the individual learning needs of pupils. . . And *[sic]* it provides a framework within which all partners in education can support young people

on the road to further learning.
(http://www.nc.uk.net/what_is.html)

In addition, Standard Assessment Tests (SATs) are carried out at the end of each of four *Key Stages* during this period. Each of the four Key Stages is designed for a specific age range. Key Stage 1 is designed for children of lower junior school age (five to seven years). Key Stage 2 is designed for seven to eleven year olds, and is assessed at the end of the junior school career. Key Stage 3 is for 11 to 14 year olds, and is assessed at the end of the third year of High School (Year 9), while and Key Stage 4 (GCSEs) is for 14 to 16 year olds.

Project Concept

‘The Blobz Guide to Electric Circuits’ is a web-based educational product targeted at 7- to 11-year olds. Within this Macromedia Flash MX-based site, there are five main sections where you can gain the knowledge required for National Curriculum units 4F – “Circuits and Conductors”, and 6G – ‘Changing Circuits’.

The hosts are a group of simple animated characters called ‘The Blobz’. The group consists of four characters in all. ‘Bob’ is simple in form but has lots of personality. He is accompanied by a few of his Blob friends including his girl friend Suzy, his inane buddy Neville and the absent-minded Professor Flobsworth.

‘The Blobz Guide to Electric Circuits’ combines various teaching methods in a product that is both educational and entertaining. In it, you learn about the basic principles of electric circuits, about the need for a complete circuit and a power source to be present. You can learn about how switches work, about which materials make good conductors, how the length and thickness of wires affects the current in a circuit, how circuit diagrams can be used to describe circuits and more.

‘The Blobz Guide to Electric Circuits’ has five main sections. These five sections cover various distinct areas of the curriculum—‘What makes circuits work’, ‘Conductors and Insulators’, ‘Switches’, ‘Changing Circuits’ and ‘Circuit Diagrams’. Each section has useful info, an interactive activity and a quiz section.

When the user has completed each section (having answered at least four out of the five quiz questions correctly), they get access to a printable certificate, which they can print out and keep to say they have completed the guide. The certificate is bright and colourful, and is personalised with their name.

In ‘The Blobz Guide to Electric Circuits’ you learn in a variety of different ways. Some children may learn from the ‘info’ sections, while other may gain more from the activities, which allow you more freedom to experiment. In all sections, though, the key information is presented outright at some time, to reinforce the information you have found for yourself.

The five main sections are accessible from a main menu area and can be completed in any order, you do not have to complete any particular section first. You can work through these five sections as you please, but the sixth section—the screen from which you can print a certificate—only becomes available when you have completed the other five sections

The look and feel of ‘The Blobz Guide to Electric Circuits’ is bright, colourful and fun, but information is presented clearly with never so much on screen as to cause clutter; this is very important when trying to communicate with a younger audience.

‘The Blobz Guide to Electric Circuits’ has fairly simple technical specifications and requirements – it will run on any browser with the latest Flash plug-in. Since it will use Flash MX code, it will need a working Flash Detection script to detect earlier (and thus, incompatible) Flash versions.

Literature Review

Theories of Teaching and Learning

Learning is one of the most important factors in our lives, and is the subject of a huge amount of study by academics of various disciplines. While there are numerous psychological theories and approaches to this matter, two approaches that are of particular relevance here are those of *behaviourism* and *constructivism*. The two are often seen as being diametrically opposed, but while these two theories of learning do differ greatly, they (along with most of the major theories) share at least some common ground (Gross & McIlveen, 1998).

For a long time behaviourism, which encompasses many of the traditional theories on learning, including those of Pavlov, Watson, Thorndike and Skinner, was the widely accepted psychological theory of learning (Alessi & Trollip, 2001; Gross & McIlveen, 1998). Behaviourism is interested in the study of changes in actual behaviour as opposed to changes in mental states. With time (in the last third of the twentieth century), another theory – the cognitive theory – became popular in the field of teaching and learning. Cognitive psychology, whose emphasis is placed on 'unobservable constructs' such as the mind, memory, attitude, motivation and thinking, took a hold during the 1970s and became the dominant theory in educational psychology. More recently, however, the newer theory of constructivism has become more popular (Alessi & Trollip, 2001).

Constructivist theory, once thought of to be a new 'fad', is now a widely accepted approach to learning (Alessi & Trollip, 2001; Dalgarno, 2001). The main premise of constructivism is that learners construct knowledge for themselves, through individually (or socially) developing ideas and concepts (Piaget, 1977; Hein, 1991; Gross & McIlveen, 1998). The distinction between individual and collective development is the basis of two of the main schools of thought within constructivist theory - cognitive constructivism and social constructivism. While there are (as with most theories in psychology) numerous variations upon the basic constructivist theory, these two are the most widely recognised. The pioneers of these theories are the renowned psychologists Piaget (for the individual or cognitive approach) and Vygotsky (for the social approach) (Gross & McIlveen, 1998).

Constructivists believe that learners build knowledge based upon the footing of previous learning (Ferguson, 2001). Furthermore, constructivism in its purest form actually dismisses the traditional form of teaching as being counterproductive in the learning experience, because "each time we prematurely teach a child something he would have discovered for himself, the child is kept from inventing it and consequently from understanding it completely." (Piaget, 1970, as cited in Crook, 1994).

In the classroom, then, constructivism translates to a new, non-traditional kind of lesson; it encourages a 'hands on' approach and moves away from the traditional lesson where the teacher's role is to present information and the pupil's role is to observe and listen (Hein, 1991). It is widely believed that constructivism presents a far greater opportunity for bringing into reality the potential benefits of Information and Communication Technology (ICT) as an educational tool (Harper, Squires, & McDougall, 2000; Oliver, 2000). In fact, the relationship between a constructivist approach and the use of ICT in the classroom can be seen as bi-directional; that is to say that not only does the use of ICT encourage constructivist learning, but also it requires constructivist thinking in order to be most effective. This idea is supported by the recommendations of Comber, Watling, Lawson, Cavendish, McEune & Paterson (2002, p.3), where "changes in lesson style to allow a less formal classroom atmosphere, greater pupil autonomy, differing modes of teacher/pupil interaction, and flexible study space" (all of which are characteristic of a constructivist environment) are recommended in order to create an environment for effective computer-based learning.

The Role of Hypermedia

There have been hundreds of studies carried out in an attempt to prove or disprove that using computers to teach is better than all the traditional methods like books, films and lectures (Alessi & Trollip, 2001). Overall, reviews and meta-analyses of these studies, as carried out by the likes of Liao (1999) and Kulik & Kulik (1986; 1991, as cited in Alessi & Trollip, 2001) have found in favour of hypermedia and computer-based instruction compared against traditional methods. However, Liao's meta-analysis states that these results are subject to significant variation; Liao states that these differences may depend upon what kind of instruction the hypermedia environment compares to. In addition learner differences may also account for a large amount of variation (McManus, 2000).

The need for the hypermedia environment to address learner differences was the subject of research by Park & Hannafin (1993, as cited in McManus, 2000), who found that when learning systems allow some level of adaptation to cater for the needs of individual learner, the system becomes more effective as a learning aid. This complies with the constructivist approach, which is very much learner-focused (Oliver, 2000) and where individuality is not only accepted, but encouraged.

This recognition of individuality, along with the acknowledgment and acceptance of multiple learning theories, greatly affects the role of the teacher or (in the case of computer-based instruction) the learning tool. These variables make it increasingly important for the required information to be presented (or, in constructivist terms, made available for discovery) in more than one way. Taking one approach to the exclusion of all others would clearly lead to a less effective teaching environment. McManus (2000) sees this as a strength of the hypermedia learning environment; citing Liu (1992), McManus tells us that the hypermedia environment allows the instructor to present information in a non-linear fashion; this allows the learner to control the flow of information, thus making it more personally relevant. This view is echoed by Dalgarno (2001), and Harper, Squires, & McDougall (2000), who particularly support the simulation approach for this very reason.

National Requirements vs, Individual Needs

So, just like adults, children are varied, diverse and individual (McManus, 2000). It follows then, that the way in which they learn is also subject to variation. However, there exists a curriculum of education that has to be followed, and on which children are assessed. The results of these assessments are made public and the schools are placed in league tables based upon their results.

In the UK, the education of children aged between five and sixteen years of age is defined by The National Curriculum (NC). The NC defines the "minimum educational entitlement for children of compulsory school age" (Qualifications and Curriculum Authority [QCA], 2002), and the progress of children based upon this curriculum is regularly assessed. Primary school children undergo standard tests at age 7, then again at age 11. These Standard Assessment Tests (SATs) form the fundamental appraisal of primary education in the core subjects (mathematics, English and science) across the country. The scholastic periods leading up to these SATs are known as Key Stage 1 and Key Stage 2 respectively. The standard grade required to pass the Key Stage 2 SATs is a Level 4 grade. The percentages of children reaching level 4 or above in 2002 in the Key Stage 2 tests range from 60 to 85 per cent by subject (DfES, 2002).

It is interesting to note that girls outperform boys in all areas of English, while boys surpass girls in science. Performance in mathematics is equal (DfES, 2002). Gender is, perhaps, the most obvious (and widely documented) difference that may play a part in children's overall performance in education. McMcanus (2000) and Gilutz & Nielsen (2002) both acknowledge and report upon this in their respective research.

So, the role of the NC is to provide the basic framework for what is taught in the classroom; the Curriculum still strives, however, to recognise the needs of the individual. These needs vary not only between individual pupils, but also between groups of children - for example, children of different ability levels, and those belonging to different demographic or socio-economic groups. The economic status of a child's family, for instance, can play an enormous role in determining the profile of the learner (McManus, 2000). In simple terms, it is reasonable to assume that children belonging to less affluent families may have had a more limited access to computers during their upbringing. As such, their prior knowledge of the medium will be significantly less than that of children from more affluent families. This prior knowledge (both of the medium and of the learning domain)—along with learning style, age and gender—is proposed by McManus to be one of the key characteristics to create individuality between learners.

Design Issues

In order to allow the required degree of user control, the structure of the flow of information in a hypermedia learning environment is very important. As such, the design of a web-based artefact for use as an educational tool offers some distinct, unique challenges (Burch, 2001). However, to say that the structure of information flow is the only design issue when creating a web-based educational tool would be inaccurate.

Burch (2001) tells us that there are four key components involved in any web site: the architecture of the site: the user interface, the information delivery method and the mode of feedback. Burch also tells us that the actual design process is made up of three separate elements: conceptual design – how the web site is organized and structured, sensory design – how the site looks and sounds, and reactive design – anything that affects the way in which the user interacts with the site.

From the sensory (or more specifically, visual) standpoint, one of the key design issues is screen layout. Good visual design is obviously of great importance, the graphic designer and the instructional technologist often sharing similar goals (Szabo & Kanuka, 1999). How objects are arranged on the screen not only affects how good the design looks, but also how easy it is to understand and use (Kristof & Satran, 1995; Nielsen, 2000). The use of poorly designed screens, therefore, can actually hinder the communication process (Heines, 1984, as cited in Szabo & Kanuka, 1999).

According to Szabo & Kanuka (1999), the key principles of effective screen layout are unity (also referred to as harmony), focal point (dominance or emphasis) and balance. Kristof & Satran (1995) also tell us that the size of items on a screen suggests a scale of importance.

The value of typography as a design factor is also without question; while all the various elements in the design of an interface play their own role, some of these elements will only ever serve the aesthetics of the design. Words, however, always have their own meaning and value, even when they are used as decoration or part of the background (Kristof & Satran, 1995).

Bernard, Mills, Frank & McKown's (2001) study, which deals specifically with the issue of font selection, and is a continuation of earlier work by Bernard, Mills, & Chaparro (n.d.), focuses specifically on children aged 9 to 11; the evidence presented by this study is, therefore, of particular relevance here. The evidence indicates that children in the age group 9 to 11 years perceive sans-serif fonts to be not only more attractive, but also easier to read than serif fonts. Furthermore, it finds that children showed a significant preference for larger fonts for screen-based type, choosing 14-point type over the 12-point alternative. The preference for larger type is supported by Gilutz & Nielsen's (2002) research, which also found that poor font choice caused frustration in children using websites, "because they were confident that they knew how to read, but the website's fonts undermined their new skills."

Research has been undertaken into the way in which children learn to read and write, and their perception of type, both printed and screen-based. Two of the main projects in this field (both undertaken through the Department of Typography & Graphic Communication at the University of Reading) are Dr. Rosemary Sassoon's ongoing typography study, and the Fabula project. Sassoon (1993) suggests that typography might better serve children's learning process when it more closely resembles the handwritten script that the children are in fact being taught; the Fabula project too finds in favour of an informal feel to the type characters, combined with long ascender and descenders to help identify the shape of the words, and a clear distinction between characters that might be easily confused (such as the lower case 'a' and 'o' characters) (Walker, 2001).

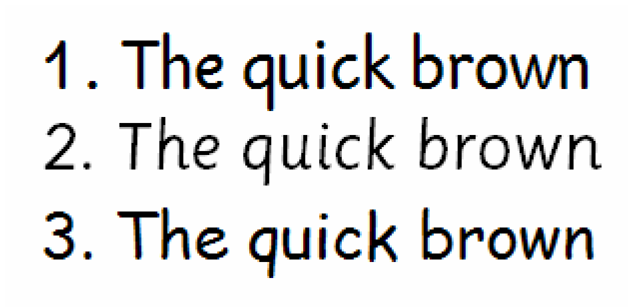

Figure 1: Examples of Fabula (1), Sassoon Primary (2) and Comic Sans MS (3)

So, the Sassoon family of fonts and the Fabula font share many similar characteristics with each other, as well as with the font Comic Sans, which was found by Bernard Mills, Frank & McKown (2001) to be preferred by children. In fact, Fabula was designed by Vincent Connare, who also designed Comic Sans. These fonts have been designed specifically with the needs of children in mind, and (with Fabula) children reading from a computer screen are taken into particular consideration (See Figure 1).

Children as Users

As indicated by this research into typography for children, when youngsters are the intended target audience, new and unique design issues require consideration (Bernard, Mills, & Chaparro, n.d.). The process of designing for children does not require a wholly different set of rules to that of designing for adults; however, there are new considerations and variations to be made to those rules if the design is to be effectively tailored for the younger user (Gilutz & Nielsen, 2002).

Children become bored and frustrated very quickly when faced with poorly designed websites. Many times, children will close the application or browser window if the information is presented to them in a way that they find difficult to understand. This is not to say that children are unwilling to learn, but rather that poor usability adversely affects children's willingness to spend time using a website or tool because "they do not have the patience to prevail in the face of complexity" (Gilutz & Nielsen, 2002, p. 3).

Gilutz & Nielsen (2002) also report numerous other issues to be considered when designing for children. For example, children were found to be particularly fond of animation and sound effects (while adults are commonly believed to dislike these and consider them annoyances); they also navigate sites and, moreover, individual screens differently to adults (tending to "mine-sweep" the screen, searching for clickable areas), and they tend to be reluctant to scroll down the page, even when there is clearly more information below the fold. These issues make it clear that, while developing effective learning materials for any audience requires an appreciation of the underlying principles of how people learn (Alessi & Trollip, 2001), designing for a target audience of children requires an extended degree of care and thought, not only for these fundamental principles of learning, or those of good design, but also for the needs of the younger user.

Method

Participants

The participants in this study were pupils from Year 6 at a local urban primary school. There were 23 pupils all aged between 9 and 11 years of age; there were 9 girls and 14 boys. The head of science at the school was also involved in the project.

The participating school has a population of 259 pupils, of which 201 are of compulsory school age. Fifty-four percent of the Key Stage 2 pupils achieved a Level 4 grade or above in English in 2001, 83% in mathematics, and 88% in science. This compares with 68.5%, 67.4% and 87.6% (respectively) for the local area, and 75%, 71% and 87% nationally (DfES, 2002). These figures show that the participant school has below average performance in English, but significantly above-average performance in mathematics. Its strongest SAT subject is science, in which its achievement was slightly better than both the local and national averages (figures are based on 2001 results).

Regular meetings with the teacher and her class were arranged so that the class could be observed while taking part in a science lesson (see Appendix G). The timings of the meetings were organised so that they coincided with lessons covering the relevant subject matter.

Time at the school also allowed an assessment of their IT facilities. The school's main computer lab has ten PCs. The machines are all Intel Pentium III based, and each has 128Mb of RAM and uses a 15-inch monitor display set at 1024 x 768 pixels at 16-bit colour depth. A pair of headphones is attached to the soundcard of each machine. The computers are connected to the internet through an internal network. The speed of the internet connection is unknown, but is permanent and certainly exceeds 56kbps. Microsoft Windows 2000 is the operating system of choice, and Internet Explorer 6.0 the browser of choice.

Four of the ten machines have CD rewriter drives; in addition, the computer lab has one large colour inkjet printer, one laser printer and a scanner.

Examples of Relevant Artefacts

The Powerpuff Girls: Mojo Jojo's Clone Zone

Figure 2: Introductory screen from 'The Powerpuff Girls – Mojo Jojo's Clone Zone'

Based around the popular children's television characters 'The Powerpuff Girls', this edutainment software package, 'Mojo Jojo's Clone Zone' (The Learning Company, 2002), is aimed at helping children to develop a number of skills, including reading, mathematics and problem-solving.

The target audience for this package is children aged six to ten years and allows the user to select on of five difficulty levels. The program includes a detailed instruction guide which is integrated into the software and is accessible from the main menu.

The aim of the game is to defeat the evil Mojo Jojo who intends to take over the Powerpuff Girls' home town of Townsville using an army of robotic clones. The application includes games such as 'Skyscraper Chaser' which is a mathematics game based on hopscotch, and 'Letter Bugs' – a word game to tidy up the streets of Townsville.

This package is fun, colourful, bright (see Figure 2) and (being based on popular TV characters) 'cool'. While there is nothing to stop boys from using this piece of software, it is surely aimed squarely at the female market, since all the characters are female and the overall style of the game is markedly feminine.

Logical Journey of the Zoombinis

Logical Journey of the Zoombinis (The Learning Company, 2001) is also a commercially available edutainment application aimed at children aged between eight and twelve years. The program is based around a bunch of characters called the Zoombinis. These characters are little globular creatures with a whole host of different features, all of which are user-definable at the offset, with five different variations for each of six characteristics, leading to 625 different potential Zoombinis. In control of these characters, the player faces a set of twelve puzzles, each of which is designed with a specific area of mathematics in mind. The puzzles promote sorting data, forming hypotheses, logic (reasoning), pattern recognition, symmetry and a host of other skills. The game uses sumptuous graphics and sound and comes on CD-ROM, compatible with both PC and Macintosh computers. It is available as part of a suite of similar games all based around the Zoombini characters, called 'Zoombinis Maths Journey'.

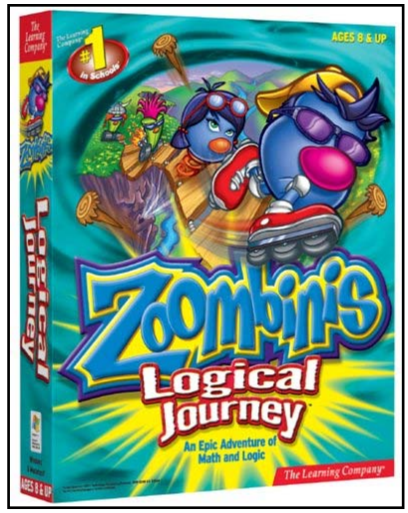

Figure 3: Colourful packaging on 'The Logical Journey of the Zoombinis'

This piece is visually excellent with luscious, fun graphics from the box to the manual and throughout the software (See Figure 3: Colourful packaging on 'The Logical Journey of the Zoombinis, and is entertaining and engaging; its 'instant appeal' factor is obvious from the outset. The puzzles are fun, appealing and varied. The user needs to get 16 Zoombinis through each section of the game before moving on; this is devised as a way to enforce practice, although it can become rather annoying, since it requires many of the puzzles to be repeated a number of times.

Electric Circuits

'Electric Circuits' (Child, 2002) is an online teaching aid created to the answer the same brief as *The Blobz Guide*. The most noticeable aspect of this artefact is its outstanding illustrations (see Figure 4), which are clear, crisp and beautifully drawn.

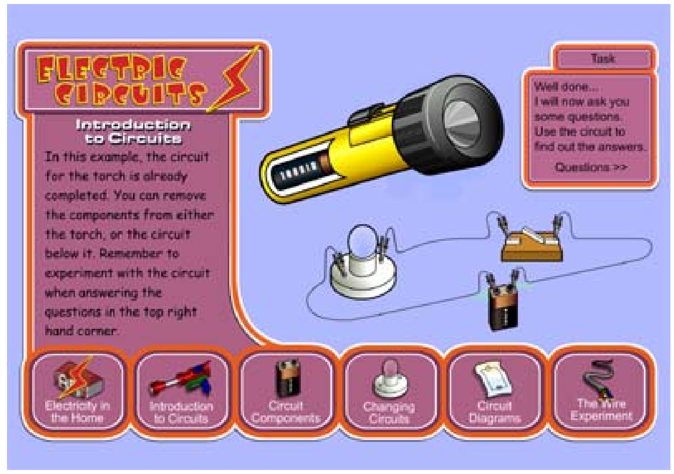

Figure 4: A screen from 'Electric Circuits' by Nick Child

The screen layout was not quite so strong, sometimes lacking balance, but this did not did not detract too much from the overall visual excellence of the piece.

The site, designed with Flash 5, is split into six sections, each one covering a certain aspect of the curriculum. The activities are very simple but deliver the message effectively. When dragging and dropping components in some sections to build a circuit, a diagram of the circuit is built concomitantly, which is an excellent way of reinforcing the knowledge of circuit symbols.

The text was sometimes outside of the natural line of sight, especially since this site opens up full screen. In addition, the low-contrast nature of the main body text (black against purple) was rather questionable. Overall though, this is a smooth, stylish and well executed piece of educational multimedia.

Pedagogical / Learning Considerations

Choice of Subject Matter

There was a wide variety of potential subjects to cover with this project, as the curriculum covers a number of subjects. At the heart of the curriculum, though, are mathematics, science and English. Approaching the participating schoolteacher, the choice of science became immediately apparent as the best option. The teacher made it clear that the children gained the most enjoyment (and appeared to learn the quickest) from those lessons in which they were able to carry out practical work. ‘They like the hands-on stuff best - it’s what they get the most out of, and even the less able kids can really grasp the ideas when they can get stuck in. They prefer it to just sitting and listening to me or reading out of a textbook’, she stated.

That children would enjoy practical-oriented worked was no great surprise, but it was interesting to note the huge amount of similarity between the teacher’s experiences and the principles of constructivist theory. Ongoing discussion with the teacher yielded the decision to make electric circuits the subject for this project.

Relating the Project to The National Curriculum

The subject matter for the project had now been chosen. Having chosen science (specifically, electricity and circuits at Key Stage 2), it was then necessary to research the content, structure and placement of the relevant units within the curriculum.

The NC defines the minimum educational entitlement for children of compulsory school age. However, it does not constitute the entire curriculum for schools. Schools ‘have discretion to develop the whole curriculum to reflect their particular needs and circumstances’ (QCA, 2002). Relating this rule to the project, it became evident that, while a degree of creative freedom would be available in choosing the finer points of the content of this artefact, the fundamental principles that needed to be taught could not be varied. The decision was made to adhere as closely as possible to the Schemes of Work that are laid out by the QCA for the relevant units (see Appendix A).

Two units of the curriculum at this Key Stage are covered, namely: Unit 4F – 'Circuits and Conductors' and Unit 6G – 'Changing Circuits'.

Unit 4F ('Circuits and Conductors') is designed to be taught in Year 4 (that is, to children of eight or nine years of age). The unit builds on the practical experience of making circuits that children should have developed at a younger age, and extends their understanding of circuits, conductors and insulators and the need for a complete circuit in order for a device to work. In this unit, children are also introduced to ways in which they can vary the current in a circuit (DfES, 1999a). Unit 6G ('Changing Circuits'), meanwhile, is aimed at Year 6 students (10 to 11 years of age), and is designed to consolidate children's knowledge of material that are electrical conductors, extend understanding of ways in which the brightness of bulbs or speed of motors in a circuit can be changed and to develop children's understanding of the value of using conventional symbols for communication (DfES, 1999b).

Deciding Upon an Approach

Preliminary research (in the form of reading and lectures) had shone a very favourable light upon the constructivist approach to learning. It was always intended that the artefact be as true to constructivist theory as possible. Originally, this brought forward ideas of a highly 'freeform' approach, where there was little or no explicit guidance or information given to the user. However, this very purist, Piagetian approach proved to be somewhat impractical.

The dichotomy between the pure constructivist approach (learner-centric, free-flowing and avoiding out-and-out instruction) and the overall educational goal of the project (needing to ensure certain criteria are met and learning outcomes achieved) called for a compromise in the way this project was approached. It was decided, therefore, that the artefact should contain sections of an instructional (and hence, essentially behaviourist) nature, but that the navigational structure should be non-linear, giving freedom to the user to complete the various sections in an order of their choice. This user control is a definite positive point from the constructivist standpoint (Ferguson, 2001). In addition, there needed to be activities that provided a highly constructive means of learning, and these activities needed to be as tactile, practical and as ‘hands-on’ as possible. Activities that simply required the child to fill in the blanks in a sentence or to name the different parts of a particular piece of equipment by typing would not be at all suitable, it was felt.

Feedback

Feedback is an important factor in a piece of educational multimedia (Alessi & Trollip, 2001; Gilutz & Nielsen, 2002). Feedback is maximised wherever possible in The Blobz Guide. During the activities, the Blobz inform the user of mistakes or decisions made. In activities where the user is required to sort items (i.e. where there is a ‘right or wrong’ response), sound is used alongside the Blobz’ messages in order to make the feedback more evident, by making it multi-modal.

As well as feedback for incorrect responses, positive feedback is also used to praise the user when they make a correct response or successfully complete an activity. Rewards are also used as positive feedback and to motivate the user.

Rewards / Motivators

As with feedback, many analysts see that rewards or motivators are of importance in an artefact design to educate youngsters (Alessi & Trollip, 2001). As stated, the goal of this project was to create a CAL package that adhered to learning theory and was based on solid pedagogical research. Therefore, it was always considered that the implementation of established learning theories would be of great importance. This led to a number of design decisions, including the use of a reward system, whereby the child is required to light up five stars (one for each section of the artefact) which would lead the user to a printable certificate stating their achievement.

The certificate printing system was designed in such a way that each child can print out a certificate with their own name on it, adding to the individualisation of the artefact. The certificate was devised as a simple form of motivator, because motivators are a well established way of creating a more effective learning experience. Since the prize is unknown to the user until they complete the tasks, the challenge of lighting the five stars and the curiosity to discover what the prize is, make this motivator more internal than external. Internal motivators are widely accepted as being more effective than external (Alessi & Trollip, 2001).

Multiple-User Options and Individualisation

In order to further personalise the learning experience, the artefact has an individualisation screen at the start. This requires user(s) to enter their names. These names are then used in the welcome screen and after completion of all the quizzes, where individually named certificates are available.

Because many school children in the target age-group will not have individual access to PCs, The Blobz Guide is designed with a multiple-user or ‘multiplayer’ option. This allows up to five users to use the artefact at once. All users are able to enter their names, and the certificate section allows each user to print off a certificate with their name on it.

Language

The language used throughout the artefact had to be given careful consideration. Using appropriate language in a piece of educational multimedia that is aimed at children is very important, because otherwise the user may feel undermined (Gilutz & Nielsen, 2002). The age range of the target audience (eight to eleven years) offered a wide range of reading and comprehension abilities. Reading materials were obtained from the participating school and these were analysed in order to discern an acceptable level of complexity for the language in the artefact (See Appendix F).

Where possible, text has been kept to a minimum in the artefact, but there is still a significant amount of written content (the importance of good font selection becomes apparent here). The wording of every passage of text was carefully considered and re-considered in order to be simple enough to be read and understood by the younger audience, without being over-simplistic or patronising to the older children in the age range. This was carried out with the assistance of the participating teacher, but still proved to be one of the most challenging aspects in the design of this project.

Design Considerations

Format

Flash MX was chosen as the format for the artefact. Flash is *the* de facto standard for web-based animated multimedia, with 98.4% of users having at least some version of the Flash Player installed on their browser in March, 2003 (Macromedia, 2003). The only other realistic choice would have been Shockwave (also from Macromedia). However, the type of content is such that Flash lends itself far more favourably to the application. Using basic HTML, although a possibility, was never really considered practical, since it did not offer any of the complex interactions or animations that the project would require.

	HTML	**Flash**	**Shockwave**
File Size	Small	Medium	Relatively large
Graphics	Bitmap only (JPEG, GIF, PNG)	Bitmap, Vector	Bitmap, Vector
Animation	Not supported	Supported	Supported
Scripting? (Language)	Yes (JavaScript)	Yes (ActionScript)	Yes (Lingo)
Plugin	None required	Required	Required
-- Penetration (as of March 2003)	N/A	98.4% (any version) 84.2% (latest version)	56.4% (any version) 42.4% (latest version)
-- Size	N/A	3,543 kb	405 kb
-- Download Time @ 56K	N/A	Approx. 1 minute	Approx. 10 minutes

Table 1: Comparison of the features of HTML, Flash and Shockwave

The MX version of Flash was chosen because it, of course, has more advanced functionality than any of its previous versions. Some of the functionality would have been impossible or, at least, far more difficult had an earlier version of Flash been selected. For example, the 'tooltips' in the artefact rely on a function specific to Flash MX. The choice to use Flash MX does mean that a smaller percentage of users would already have the required plug-in installed, since Flash MX movies require Macromedia Flash Player 6 browser plug-in.

The percentage of users in Europe with this version of the Flash plug-in stood at 84.2% (Macromedia, 2002) in March 2003, and was only 61.33% in September 2002. These figures demonstrate a fast-moving uptake of the latest Flash plug-in technology. However, these figures still leaves 15 or so percent of users with an out-of-date plug-in. Luckily, Flash is an 'install-on-demand' plug-in and is therefore capable of popping up a system dialogue box in the user's browser, asking if they wish to upgrade to the latest version. In addition to this, it was decided that comprehensive Flash detection script should be added to the front of the site to make sure that anyone entering has the correct version of the Flash player.

Graphics

All the graphics within the project itself (excluding those on the homepage and within the glossary) are vector-based. The decision to use vector graphics was based on a number of reasons. Firstly, vector graphics are the ‘default’ standard for any Flash artefact. Vectors yield a greatly reduced file size when compared with their bitmap-based counterparts. In addition, vector graphics can be scaled or ‘zoomed’ in and out with no loss of quality. Also, the visual style of the artefact required nothing that could only be provided using bitmap graphics.

Colours

The main colours chosen for the design of the artefact were bright and bold, because this makes it more appealing to a younger audience (Gilutz & Nielsen, 2002). Pastels, greys and subtle shades of the same colour, while very popular and modern, would be totally out of place in an artefact for the target age range.

Purple and green were chosen as the two main colours, but the artefact also makes some use of orange, yellow and white in its text and surroundings.

Bright colours were chosen in an attempt to make the artefact appealing to a young audience. Because of the relatively wide age range of the target audience, the colours (as with every element of the design) needed to be fun enough to appeal to seven year olds but ‘cool’ enough to be appealing to eleven year olds, without appearing too ‘childish’.

Fonts

The choice of font is among the most important decisions to be made in an artefact of this type. If a poor font is chosen it can have a serious adverse effect on the design, making the text less readable and the system generally less usable (Bernard, Mills & Chaparro, n.d., Gilutz & Nielsen, 2001; Kristof & Satran, 1995). The issue of font selection is even more important when designing for a younger audience (Bernard, Mills, Frank & McCowan, 2001; Gilutz & Nielsen, 2002). Research suggested that Comic Sans was popular among children, and that the font 'Fabula' was created as a next generation of Comic Sans (Walker, 2001), specifically for use on screen. Fabula shares many of the features of Comic Sans, being fun, informal and bold. However, Fabula also possesses a number of added features including extended ascenders and descenders, and a noted variatior between the lower case 'a' and 'o'. These features make the font all the more readable (Walker, 2001; Sassoon, 1993) and led to the decision that the main body copy typeface should be Fabula.

The font 'BeesKnees' was chosen for the large main title text. This font is extremely bold, curvy and fun. It was clear that such a font would be wholly unsuitable for use as body copy since it would be incredibly difficult to read, being, as it is, made up of unusual shapes, making it unsuitable for application at small sizes (Sassoon, 1993). However, for use as a main title, where it would be used at a very large size and for only two words, this font seemed very appropriate.

Sound

The decision was made to use sound sparingly but to maximum effect in the artefact. Sounds were used in the most part to enhance the tactile nature of the activities, or to provide a more positive response to navigational items such as the main menu buttons.

Characters

It was decided early in the design process that characters should be used in the artefact, because the use of characters is believed to be one of the necessary traits of a piece of successful educational multimedia (Jonassen, 1991; Wilson & Cole, 1991; Ernest 1995; Honebein 1996; as cited in Ferguson, 2001).

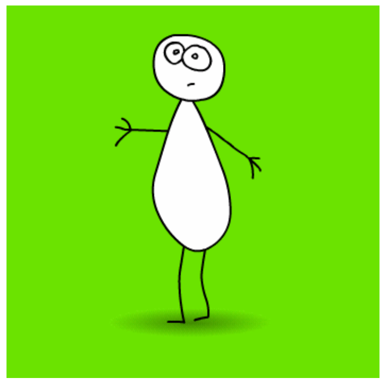

Figure 5: Sticky Bob, who was scrapped early in the design process

Originally, the idea was to use a simple, comical stick-man called Bob ('Sticky Bob', in fact) (See Figure 5). However, when Sticky Bob was shown to the participating children, their response was not entirely enthusiastic. It became clear that Sticky Bob was more in line with what teenagers or adults might find funny or appealing, containing many of the same characteristics as the popular 'Purple Ronnie' characters that proliferate popular teen / adult culture in the UK.

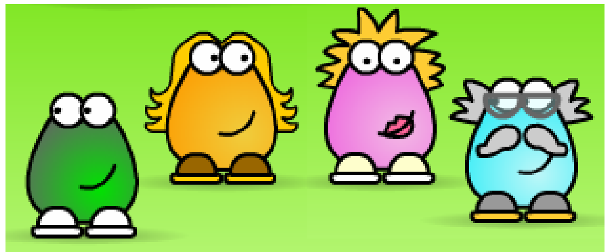

Figure 6: 'The Blobz', who proved very popular with the target audience

Further consideration brought forward the idea of The Blobz (See Figure 6). The Blobz are simple, colourful and fun; their characteristics seemed far more suitable for the target audience, and when the class were shown printouts of the characters, this proved to be the case. The Blobz were given bright colours in order to be ethnically non-specific, and the four characters were divided evenly by gender—two male and two female—in an attempt to be as evenly representative as possible.

Structure and Navigation

Deciding upon the structure of the artefact was one of the earliest elements in the design process. Once the overall content had been decided upon, a node map was devised, which gave a solid and easy-to-follow plan of how the project would be structured.

The Blobz Guide is split into five distinct sections. Each section covers a particular area of the curriculum and contains an information area, an interactive activity and a mini-quiz.

The navigation of the artefact needed to be kept as simple as possible. This is usually a 'golden rule' anyway, but given the young audience, it was even more important. A simple icon-based menu system was devised, with the five sections of the artefact represented by bold, circular buttons along the bottom of the screen. The three sub-options for each section (information, activity and quiz) appear as smaller icons in the bottom-right corner. The navigational elements were grouped together this way because it is important that elements of the interface that have similar functions be positioned together (Szabo & Kanuka, 1999). The navigational elements remain in the same position, never moving or changing in meaning between screens, in order to maintain consistency; this is of key importance when designing navigation (Gilutz & Nielsen, 2001).

Key Elements of the Artefact

Information Sections

The information areas provide key information in each of the five main sections of *The Blobz Guide*. In the early planning phase, these sections were not intended for inclusion in the artefact, since they have more of a behaviourist slant than constructivist, which was originally seen as a negative point. However, it became apparent that these sections *should* be included in order that the most important information (that which is central to the learning outcomes) could be directly accessed. The navigation of the artefact, being non-linear, means that the user can (if they wish) skip these sections and proceed to the activities or quiz.

The information is presented on white ‘screens’ using simple text and bold, colourful graphics. Each section has 4 ‘screens’ of information, which can be flipped through by the child using ‘Next’ and ‘Back’ buttons, which were designed to resemble VCR type controls, since these would be familiar to the young audience (see Figure 7). The decision was made to allow the user to control the screens, rather than have them simply cycle through as a slideshow, because the slideshow approach would be far too passive, it would diminish user-control, and could not cater for the variation in reading ability between users.

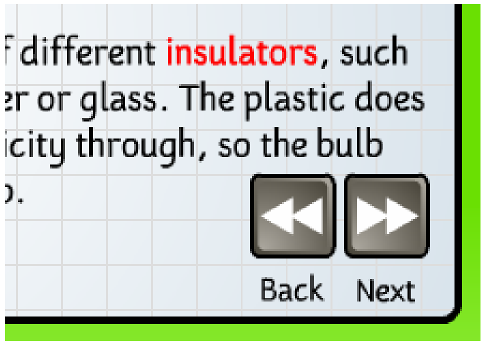

Figure 7: The VCR-style buttons that control the information screens

Activities

Each section in *The Blobz Guide* has an activity. The activities are designed to reinforce the knowledge required for the learning outcomes.

Section 1: 'What makes circuits work?' – Drag 'n' Drop Pin-board

This activity is designed to enhance children's ability to distinguish between circuits that will work and those that will not. The user is required to sort six circuits, represented as pictures pinned to a board, by dragging and dropping them onto the correct boxes ('will work' and 'will not work').

Feedback is given in the form of a message from the Blobz, as well as a sound to denote a right or wrong decision. Given an incorrect response, the feedback aims to be constructive and to prompt the user to note where they have gone wrong.

Section 2: 'Circuits and Conductors' – Household Items Conductivity Test

The activity in this section is designed to allow the user to test whether ten household items conduct electricity or not. On selection of each item, a message is displayed to prompt the user to consider what they have chosen, and hopefully form a hypothesis in their minds as to whether or not the item will conduct.

The items included in this section include a pencil (to reinforce the knowledge that graphite is an electric conductor), and a knife with a plastic handle (to reinforce the fact that metal will conduct electricity but plastic will not).

Section 3 – 'All About Switches'

The approach taken with this activity was to prompt the user to sort nine items into those that have no switches, those with only one switch, and those that have many switches. The idea here was to relate switches (and the idea of electric circuits on the whole) to real items that children would know and use (a stereo, mobile telephone, lamp, calculator etc.), in the hope of having them see electric circuits not only as abstract and experimental things used in the classroom, but also as real and tangible things used in everyday life.

Section 4 – 'Changing Circuits' – Drag and Drop Circuit with Multiple Components

This activity aims to reinforce the idea that the properties of circuits can be changed by the addition or removal of components, or the changing of a length of wire.

The user can add more cells or bulbs to a circuit and is prompted to note the effect upon the brightness of the bulbs. Additionally, the length of a piece of connecting resistance wire can be altered, and again, the effect noted. The need for a fair test is made evident in the directions given by the Blob character. It was important that this be made clear, because this is of key importance and is a part of the required learning for the children. The fair test is not enforced programmatically, however, because it was felt that it was more important that the children learn to apply this rule themselves.

Section 5 – 'Circuit Diagrams' – Mix & Match Symbol Game

This activity takes the form of a mix-and-match game and is devised to reinforce the user's recognition of five basic circuit symbols.

The user is required to match the name and picture of the five components used throughout the guide (cell, bulb, buzzer, motor and switch) with the standard circuit symbol for those components. The names, pictures and symbols are randomised in five columns and can be flipped through using arrows. When the user has made a correct match, the light at the bottom of that column turns from red to green. In order to stop the user repeating the same component in more than one column, the lights will turn yellow if a correct match is made but that component is already matched in a different column. Sound and messages are again used as feedback in this activity.

Quiz

The quiz is split across the five sections of the guide, but is the same in its style and format each time. Each section of the quiz contains five multiple-choice questions. The mode and format of the questions are varied in order to avoid repetitiveness. Visual questions are also used where possible in order to add variation.

The results for the section are given after all five questions have been answered, with constructive feedback being given where necessary. If the user answers at least four out of five questions correctly, they are awarded the star for that section. The stars light up with a chiming 'fanfare' sound to provide positive feedback on this achievement.

Help and Glossary

The 'help' button pops up a 'window' containing context-sensitive help. The help is given in simple words and explains exactly what should be done for the current activity or quiz.

A glossary is also available, which explains the meaning of important words. Words with a glossary entry are highlighted in red within the program. The glossary opens up in a new JavaScript 'popup' window, in order to avoid interference with the main program.

Home page

The home page contains a graphic introducing the artefact by name with the four Blob characters shown, along with a selection of graphics from the main artefact. The tagline 'An interactive learning tool for Key Stage 2 Science (Units 4F and 6G)' also appears on this screen.

This screen was designed to be appealing to youngsters while still maintaining a slightly 'grown up' feel to give the most professional image possible.

From this screen, there are three possible options: 'About This Site, 'Download Macromedia Flash Player', or 'Enter'.

Download Macromedia Flash Player

The 'download Macromedia Flash' button opens a pop-up window with some information about the Flash plug-in, and the option to download it if you do not already have it. A new window is used to avoid directing the user away from the artefact itself. While the need to use this button should be quite limited, (since Flash player will 'install on demand' on newer browsers), the presence of this button on the homepage also serves to act as a sign that the site contains Flash content.

About this Site

This page, which launches in a popup window, contains all the information that parents or teachers may need to know about the site and the artefact. It tells parents and teachers what is contained within, and how it relates to the education of their child or pupil. On this page, parents and teachers are made aware of the intentions of the Blobz Guide, and that it relates to science units 4F ('Circuits and Conductors') and 6G ('Changing Circuits') of the National Curriculum for Key Stage 2.

Results

Background

In addition to the pre-production feedback gathered from the participants, which led to the decision to use the Blobz characters, user testing was carried out at the participating school over two separate occasions. Visits were also arranged with the teacher in order to discuss the wording used within the project, and to validate the questions used in the quiz. Furthermore, general bug testing and gathering of opinions was gathered from other volunteers, including the use of a 'Buddy Board' forum. The first testing session at the school took place early in the development process in order to establish opinions on the core issues such as the layout and the navigation. The second session was carried out later in the development and was used to iron out any issues before the project was finalised.

During both test sessions at the school, the children were working in their usual groups of two or three per computer. The first test session consisted of asking questions of the children in an attempt to gauge opinions, since they were unfamiliar with the artefact. The second session however, saw the children voicing their opinions more openly.

Figure 8: The printable certificate panel, which becomes available on completion of the Blobz Guide

Problems Encountered and Changes Made

Reward System

As a result of user testing, it became apparent that changes were required to the reward system. The original idea implemented in the project was that on completion of the five main sections of the guide, a sixth section would be ‘unlocked’. This extra ‘bonus’ section would be a circuit building kit where the children could create circuits from a number of components. However, when shown an early incarnation of this bonus section, the majority of those asked were rather unimpressed by this section. It did not appear as a type of reward. One child (male, 10 years old) said “It’s the same as the other part… is this the bonus game? I don’t like this bit.”

Given this feedback, the decision was made to replace the circuit building kit with a printable, personalised certificate (see Appendix B and Figure 8). It was felt that this would be a more suitable bonus, more of a reward, and something permanent for the kids to keep.

Name Input Text Box

Originally, the text box at the start of the program in which the user has to type their name did not automatically receive focus (i.e. the cursor was not automatically placed within it). While many of the children seemed to have no trouble in realising that they had to click in the box first, a number did start typing without having clicked in the box.

This problem was easily remedied by adding ActionScript code to the name input dialogue box, giving focus to the text input box by default.

Tooltips

Tooltips were added after the first test session in order to remedy a problem that was noticed with some users, who seemed a little unsure over what some of the buttons did in the project. The tooltips work not only for navigational elements, but also on other items such as the drag and drop objects in the various activities.

Drag and Drop

Problems were encountered with some users on the drag and drop sections of the artefact. The draggable items originally had no sound and did not resize when moved. Some children had trouble recognising the fact that the items had been “picked up”.

As a result of this, the drag and drop sections were reworked, adding sounds and a resize feature to make the selected items get larger when being dragged. This helped to increase the tactile feel of these sections and made it more obvious what was occurring.

Navigation

A number of changes were made to the navigation both as a result of the testing at the school and based on other gathered opinions. A central ‘main menu’ screen was included in the original design, but this was scrapped in favour of an always-present menu at the bottom of the screen. This not only reduced the amount of ‘clicks’ required to navigate around the site, but also made use of the screen space much more efficiently.

Quiz

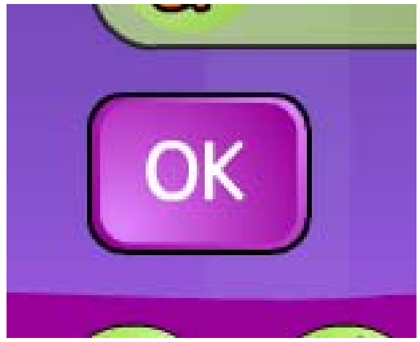

Figure 9: The OK button was added to the quiz as a result of user testing.

User testing on the quiz sections of The Blobz Guide brought up a problem with the way these sections worked. The quiz was originally set up to move on to the next question as soon as the user had chosen one of the possible answers. However, a number of users found that they had clicked an answer, and then reconsidered, but the quiz had moved on leaving them no way to change their answer. This led to the addition of an “OK” button that would allow users to confirm their decision before moving on.

Further, more extensive, user testing could be carried out if the artefact were to undergo a new revision in the future. However, the testing that was carried out proved to be informative and useful in the development of this version.

Recommendations

Future Developments

The development and testing of *The Blobz Guide*, and the changes made as a result have led to an artefact that is generally pleasing and fulfils the aims originally laid out for it. However, there are a number of changes that could be made in order to improve the artefact, making it a better piece of educational multimedia.

Use of Motors and Buzzers

The ‘circuit builder’ bonus section, which was removed as a result of user testing, contained buzzers and motors, in addition to cells, bulbs and switches. Having removed this section, however, the main components used to demonstrate the various circuits are the bulb. More variation here, with use of buzzers and motors would be beneficial.

Improved and/or Updateable Quiz

The quiz currently contains 25 multiple-choice questions, which remain the same each time the artefact is used. It may be advantageous if the quiz had a larger bank of questions that could be presented in a random order. This would add longevity to the project, and (where the artefact is used in the classroom), would stop groups of children simply copying a list of answers from their friends. An extension of this idea would be to add a dynamic database-driven quiz system, where new questions could be added quickly and easily from an ‘admin’ area.

More User Testing

Although the user testing for this version of the project proved fruitful and very useful, it would be of great advantage if testing could be carried out with other groups of children, of different abilities and ages. The participants in this project were all aged ten to eleven years, which is not entirely representative of the target age range (eight to eleven years).

Offline Content

The addition of worksheets or a printable booklet to accompany The Blobz Guide may help in creating a more rounded, multi-faceted learning experience, giving children a resource to work with away from the computer. These worksheets could include questions about the activities, aiding children to form hypotheses regarding what will happen on screen.

Progress Checking

A facility where children can 'log in' to the program and save their position each time would allow teachers or parents to check their progress.

Improved Preloader

The preloader for The Blobz Guide was designed to be as simple (and small in file size) as possible, because a preloader that takes time a long time to load is rather self-defeating. However, a more visually appealing preloader might be useful in maintaining audience interest for the time taken to download the artefact (around one minute on a 56K modem).

Better Multi-User Functionality

The current multi-user elements in the Blobz Guide are rather limited. Only the name input at the start of the program and the individually named printable certificates on its completion are geared towards multiple users. The addition of multi-user functionality to the main activities would make the program more suitable for use by groups of users, leading to a richer, more fulfilling learning experience.

Conclusion

Developing *The Blobz Guide to Electric Circuits* proved challenging and interesting. Conducting primary and secondary research, then applying it to the development of a project has shone a new light on the importance of understanding the needs of the target audience. User testing returned very positive feedback, combined with criticism that proved useful in the development process.

Designing for a young audience brings up unique design issues (Gilutz & Nielsen, 2002). Discovering these issues of psychology, design, language, pedagogy etc., and addressing them in the design considerations can lead to the development of a stronger and better-rounded piece of educational multimedia, and it this, I believe, is true of *The Blobz Guide to Electric Circuits.*

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Appendix A – QCA Schemes of Work for the Chosen Units

(see over)

Appendix B – Example of Personalised Printed Certificate

(see over)

Appendix C – Font Candidates

The quick brown fox jumps over the lazy dog.
Comic Sans MS

The quick brown fox jumps over the lazy dog.
Arial

The quick brown fox jumps over the lazy dog.
Fabula

The quick brown fox jumps over the lazy dog.
AG Book Rounded

The quick brown fox jumps over the lazy dog.
VAG Rounded Light

The quick brown fox jumps over the lazy dog.
Sassoon Primary Italic

Appendix D – Software Used in the Design / Build Process

The software used in the development of the artefact was as follows:

- Macromedia Flash MX

  Flash was the main development tool, used for creating the finished piece.

- Macromedia Dreamweaver MX

  Dreamweaver was used for creating the layout of the homepage.

- Adobe Illustrator 10

  Illustrator was used for creating much of the vector graphic content of the artefact.

- Adobe Photoshop 7.0

  Photoshop was used to build the image on the home page, to slice it up and optimise each slice for the best quality to file size ratio.

- Sonic Foundry Sound Forge 6.0

  Sound Forge was used as the audio editing package for this project.

- Electric Rain Swift 3D 2.0

  Swift 3D is a package that allows the creation of vector-based 3D graphics. It was used to create the spinning “info”, “activity” and “quiz” symbols.

Appendix E – Node Map

(see over)

Appendix F – Example Reading Material for the Target Age Group

(see over)

Appendix G – Client Agreement & Project Sign-Off

(see over)