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Honours Project Final Report

"Investigating the HCI of Dr. Kawashima's Brain Training software on the Nintendo DS and the affect this has on children within primary school education"

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"Except where explicitly stated all work in this document including appendices is my own."

Signed:_____ Date_____

Abstract

Children now, more so than ever before, stand to benefit from the use of computers within the classroom. The main method of introducing computers into education and in particular primary education is through the use of edutainment software or "serious gaming". This is seen as a good way of engaging children with the educational content of the software since many children enjoy playing video games outside of class. In order to maximise the user's interest and engagement of software it is important for the design of the package to incorporate good quality HCI. One package that has appeared in recent time is Dr. Kawashima's Brain Training on the Nintendo DS and it was this package that was chosen to be evaluated for its use as an educational tool within primary education.

In this report a class of school children from a local primary school were selected to evaluate the HCI of Dr. Kawashima's Brain Training. The children were performing an experiment that involved using this particular game for 20 minutes of class time every day and as such were considered ideal as evaluators of the software. Three separate data gathering techniques were chosen to be employed to obtain the relevant information from the primary users and the teacher who was in charge of the class during the course of the experiment.

After careful consideration it was decided that data gathering would best take place through employment of an observational technique known as cognitive walkthrough or "think-aloud" and semi-structured interviews with the users. In reflection the data gathering techniques employed may not have encouraged users to provide the information necessary to perform a satisfactory HCI evaluation of Dr. Kawashima's Brain Training on the Nintendo DS with children in primary education as the main user group.

The results concluded that Dr. Kawashima's Brain Training provided the user with a unique interface and by utilising touch screen technology combined with video game design techniques provided encouragement for primary school aged children to engage in maths based learning.

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1. Introduction

Computers and IT have been an aspect of children's education for many years now. Ranging from the BBC Microcomputer to modern PC and Mac desktop machines there has been a traceable progression of incorporating novel and innovative technology into the standard school classroom through the years.

As people become more accustomed to using computers for educational purposes, the way in which they interact with computers has progressively matured. This could possibly be attributed to the fact that modern society is far more immersed in computer use than ever before (Westera *et al*, 2008).

Whilst the incorporation of computers as an aide to learning has advanced, relatively little effort appears to have been employed in pushing this technology and design understanding towards the creation of consumer friendly educational software. On reflection the majority of educational software until present has been met with a relatively unfavourable reception due to the lack of input from the end users themselves, namely children who are attempting to learn from the use of the various packages.

One explanation that may be put towards the general lack of success of many educational software packages could be attributed to design flaws within these packages that put a barricade between the children and the content they seek to consume. Many developers seem to fail in balancing education and entertainment by focusing too heavily on one of these sides and neglecting the other entirely.

Computer and video games are a large scale business sector in the modern world with many children regularly playing video games. Certain platforms already have a limited catalogue of educational games associated with them yet very few are highly acclaimed, seen by the low levels of sales and poor user reviews of these titles (Gamespot, 2009).

One breakthrough title which has emerged in recent times in the step towards popular and useful educational software with entertainment value can be seen in the Nintendo DS (Dual Screen) handheld games console release of "Dr. Kawashima's Brain Training: How old is your Brain?". Even though the original concept of the game did not have children's education at the forefront, the game does however have particular merit in the education of particularly young school age children. The software also had the benefit of a basis in video game design and exceptional promotion as well as endorsement by Dr. Kawashima himself who made some very serious claims as to the potential health benefits gained by applying the use of this software (Kawashima, 2005).

1.1 Background

On the 10th of March 2005 Saturo Iwata, President and CEO of the Nintendo Corporation, delivered a keynote speech (IGN, 2008) wherein he explained the origins of a game known in the western world as "Dr. Kawashima's Brain Training: How old is your brain?". This game falls into a video game market that had been relatively unseen outside of Japan until recent years. In Japan the market is referred to as "Noh Tore" (lit. "Train the mind"). The market for Noh Tore software in Japan is so strong that at various points in their video game history there have been product shortages due to overwhelming demand for new titles. Of all the Noh Tore available, Dr. Kawashima's Brain Training is the most popular. According to the creator the game boasts a very real benefit in the fight against dementia.

Mr Iwata's speech revealed that the game was initially conceived with a mature audience in mind and hinted at the health benefits that Dr. Kawashima himself talked about extensively in his research concerning regular "Brain exercise". The premise of the game was derived exclusively from a book written by Dr. Kawashima that had proved popular in his native Japan. The book was entitled "Train Your Brain: 60 Days to a Better Brain" and is set out in a series of daily worksheets with accompanying tables to record and calculate the consumers progress. Mr Iwata proposed to build a game around the concept of this book with the idea of fusing entertainment with education in a suitable balance and then delivering the result in a digital format suitable for a mature populous who until this point had been ignored in the video game market (IGN, 2008).

The popularity of this title had been attributed to the decision by Nintendo to release the game on its already popular and innovative DS handheld games console. The console itself is portable and discrete and therefore perfect for users to take advantage of the game just about anywhere they wish such as commuting to work as well as relaxing at home. It is interesting to note also that through promotion of the game to the elderly, there was an upsurge in sales in the few days prior to Japan's "Respect the Aged Day" even though prior to Brain Training the DS was typically viewed as a youth oriented console (web-japan, 2006).

The fusion of education and entertainment is not a new concept and is often referred to by the term "Edutainment" (a composite of the phrase EDUcational enterTAINMENT), literally referring to a form of entertainment designed to educate as well as amuse.

Edutainment has had strong links to computing for many years, originally tagged on to a software package released in 1983 for the Oric 1 and Spectrum Microcomputers by Christopher Harvey who worked for Telford ITEC (Answers, 2008).

At a base level Dr. Kawashima's Brain Training has a question and answer process similar to that of a quiz. The player answers some fairly simple mathematics, perception and logic questions in quick fire succession and in return is presented with a score representative of their brains "age". Age is merely a measurement based upon the average activity of a healthy brain from the ages of 20 to 80 (20 being the best score available and 80 being the worst).

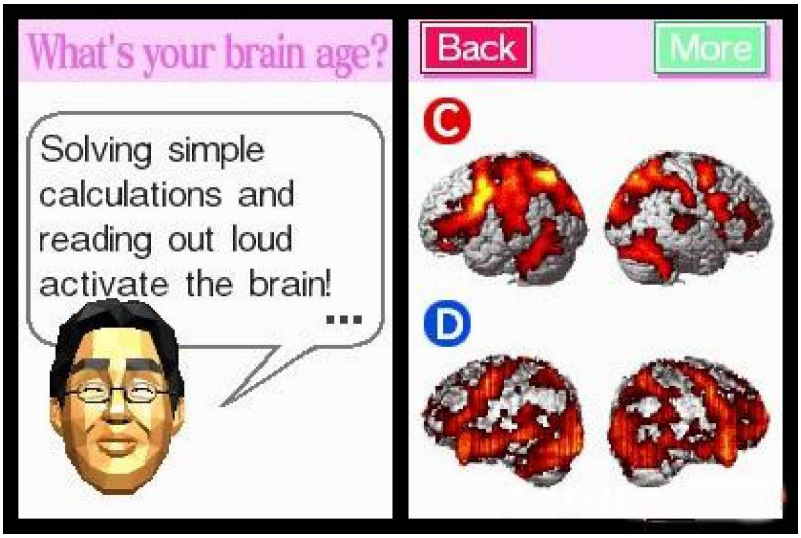


fig 1. Screenshot taken from introduction of game indicating brain activity.

Figure 1 is displayed to the user during the introductory section of the game. Sections C and D are both depictions of scans showing brain activity and taken from research conducted at Tohuko University's New Industry Creation Hatchery Centre in Japan where Dr. Kawashima is a resident brain analyst (bcs, 2006). The coloured sections of each scan are the areas of the brain that are active during various activities. Diagram C shows both hemispheres of the brain whilst the test subject is solving simple mathematics problems in quick succession and Diagram D is a similar dual hemisphere illustration of activity in the brain whilst the subject reads aloud a passage of text (InsideGamer, 2008).

The left hand side of the image shows an avatar of Dr. Kawashima himself who acts as the virtual agent who guides the user through the use of the package. In an effort to enhance educational applications, researchers have studied how to increase user engagement within learning experiences. Pedagogical agents have been employed to good effect to provide students with useful help and advice in response to their problem solving activities. Animated pedagogical agents such as the one used in Brain Training have a persona effect that has been proven to increase user motivation. Agents' rarely present connection to a real environment where the user actually exists and this spatial gap can be viewed as a reason for users loss of interest in current computer aided learning packages. The virtual agent's focus on explicitly guiding users as solely instructors can be off-putting and in the extreme disturb the user thereby reducing motivation in educational settings. In order to offer more effective ways to improve users' learning experiences edutainment systems need to give the agents a less intrusive guidance for motivating the user to engage more with the system (Kim *et al*, 2007).

Dr. Kawashima pointed out in his book (2005) that simple calculations performed quickly activate sections of the human brain far more effectively than exposure to complicated puzzles and conundrums.

When Brain Training was devised the DS technology was still relatively new to the customer who allowed the designers to take certain liberties with regard to user intuition as it seems logical that any new delivery platform will require a transition period for users to adjust to the device before being comfortable with the general operations and functions.

Kim *et al* (2007) indicate that handheld devices have several important characteristics including being small, portable, lightweight, ergonomically designed and powerful enough to handle various types of multimedia.

Marketing and sales trends

The marketing of Dr. Kawashima's Brain Training added to the focus of the mature user by being the first Nintendo product to ever be advertised in Saga Magazine (BBC, 2006), a publication with an exclusive market of people over the age of 50.

When the game was released the sales figures appeared erratic when compared to those of traditional video game sales as illustrated in the following sales and demographics charts;

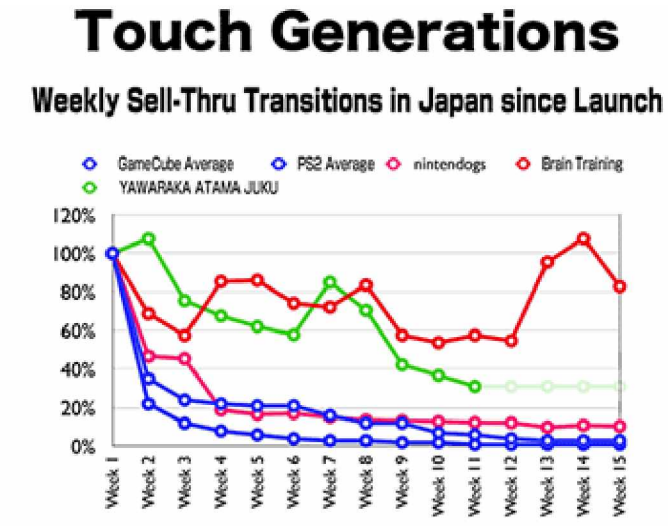


Figure 2

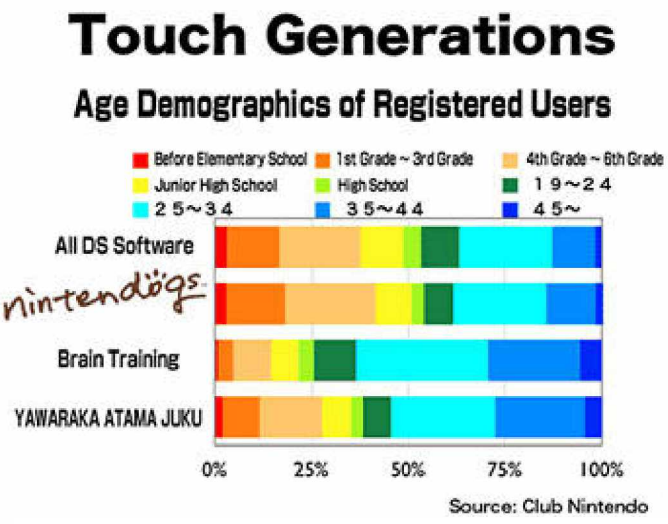


Figure 3

Figure 2 displays the sales trend for traditional video games graphed as sales over time. The figures for Brain Training (seen in red) follow a traditional sales pattern for only a short time before bucking the trend and having a resurgence of sales 3 weeks into its launch. This then remains level for a prolonged length before dipping again before a second resurgence which appeared to rise higher than even the initial sales. This phenomenon may be attributed to the fact that the game itself was rapidly building a healthy word of mouth reputation and with few competitors offering similar products the game could be considered a pioneering title. The success of the game came as a shock to Nintendo and the fragmentation of the consumer market was somewhat unexpected.

Figure 3 illustrates that there was relatively low uptake from consumers over the age of 45. The largest volume of sales within a single user group could be seen in the traditional 25-34 market however overall the greatest sales success came from users under the age of 25.

Gaming in modern times has formed an entirely new culture. Using the results of a survey conducted by Ezinearticles (2006) it was discovered that 35% of gamers were under the age of 18, leaving 65% of video game players aged 18 or above and the average gamer is declared as male and around the age of 25.

Consolarium

In 2007, Dr. Kawashima's Brain Training became the focus of an experimental research amongst school children in Dundee arranged by Learning and Teaching in Scotland (LTS) via its Consolarium initiative. This study monitored the affects that playing the game for 10-15 minutes before lessons had on the performance of pupils in comparison to those who did not use the game. Findings indicated that there were recognisable improvements amongst the children using the game in the form of better results in tests, improved concentration levels and general enhancements in classroom behaviour (BBC, 2007).

In October 2008 the initiative was taken to incorporate the Nintendo DS into schooling throughout the UK. Teachers attending the Handheld Learning Conference in London were issued with a complementary DS console and a copy of Dr. Kawashima's Brain Training to review the potential of the machine and the software as an educational device (Gibbon, 2008).

Children in primary education appear to be an appropriate user group to benefit from educational software currently more so than ever before since the younger generation have grown up immersed in new communication technologies (Prensky, 2006). Selecting children as the primary evaluators within this project is a credible choice since they are the intended user group. Druin (1999) points out that although children are seen as good evaluators they do lack depth in knowledge of computer operations. For this reason it seemed wise for an expert evaluation from the teacher involved in the experiment to be sought in order to confirm and expand on findings.

It is also important to note that usability is closely related to enjoyment of use.

1.2 Aims and objectives

The purpose of this project was to investigate if the human computer interface of Dr. Kawashima's Brain Training on the Nintendo DS is interesting and engaging with regards to a case study of 23 children in a Scottish primary school.

The project will make use of an experiment that was devised by the schools local authority to evaluate the benefits of using the Nintendo DS with Dr. Kawashima's Brain Training as a learning device to encourage primary age children to take an active interest in learning mathematics. From this study it was also expected that there would be a degree of impact upon engagement and learning through the use of using a games console as a teaching device so although being designed with an older user in mind there could be a place within the curriculum for the use of this game for the education of primary school children. Because the experiment had already been implemented the project focussed on utilising the resources to determine specifically the HCI of the game and evaluate user interest and engagement. The experiment was the second in a series devised by the council initiative and was set to run for the course of one full term at the school per class involved.

Research Question

The research question upon which the project is based is;

"What effect does the HCI of Dr. Kawashima's Brain Training software for the Nintendo DS have on the teaching of mathematics to children in primary education?"

Objectives

The primary aims of the project to answer this question are;

1. Review the use of computer games within education.
2. Determine methods of measuring user engagement with of children aged 7-9.
3. Determine methods of evaluating HCI with respect to children aged 7-9.
4. Discuss the perceived engagement with an expert user.
5. Devise a data capturing technique or techniques based upon evaluating HCI that is appropriate for children aged 7-9.
6. Devise a data capturing technique or techniques based upon evaluating user engagement that is appropriate for the expert user.
7. Use the result of the data capturing technique or techniques to form a conclusion of the engagement of children aged 7-9 using Dr. Kawashima's Brain Training on the Nintendo DS as a learning device.

2. Literature Review

2.1 Human Computer Interaction

The primary frontier separating the user from the functionality of software is embedded in the design of good Human Computer Interaction (or HCI). Good HCI design as highlighted by Nielsen (1994) can be the key to user understanding, ease of use and ultimately enjoyment and interest in any designated system. Nielsen predefines a set of usability guidelines developers are encouraged to follow to ensure the design produces the greatest benefits possible. These rules are also referred to as Nielsen's "Usability Heuristics" and can also be employed as a valid method of evaluation as well as design conditions. The usability heuristics are discussed more in depth in a later section of the report. Nielsen also points to the importance of a match between system and the real world. This match he states should be logical and comfortable for the user and not baffling or cluttered with technical jargon. The priority of the design is essentially to ensure the comfort of the user and it is to this end that HCI earns its merits.

The realisation of HCI as a recognised discipline within the field of computing forced the spotlight of system design away from issues of processing power and programming convenience and more towards the overall look and feel and general usability aspects of the final products. When developers realised that the end user was the most important benefactor of a system that was being implemented the real advancements in user engagement and uptake of software and computer systems was acknowledged. The pinnacle, or at the very least a major milestone in HCI must be said to be the Graphical User Interface (GUI) (Newman *et al*, 1995).

After the inclusion of so called "user-friendly" systems the success rate and productivity of software began to increase dramatically. GUI's allowed the user to access files and to perform functions with relative ease for the first time as opposed to the command driven functions previously seen in operation. This innovation allowed far more people to become familiar with computing as an accessible practise. The purchase and usage of most software packages can be directly attributed to the appeal of each individual package and the users' feelings of engagement as well as brand loyalty and cost (Newman *et al*, 1995).

For user engagement it is vital that the user feels at ease with the data they are presented. As suggested by Norman (1988) "If users cannot operate a system they may attribute this to their own stupidity". This would not be acceptable practise for a software developer and would certainly lead to poor recommendations from peer and public alike. There are a number of usability factors that must be taken into account with any software package including;

- Overall robustness
- Ease of maintenance and upgrade
- Security
- Social acceptance

(Newman *et al*, 1995).

2.2 Serious Gaming

Dr. Kawashima's Brain Training falls into the bracket of "Serious Gaming".

Serious gaming is a concept within computer and video game design which combines classic game design (Sweetser *et al*, 2005) and the theory of flow (Sweetser *et al*, 2005) then applying these theories to attempt to solve a real world problem.

Serious games are also sometimes known as "functional games" or "social impact" games and have been developed for a number of reasons however education is the most standout field amongst these. They combine learning and playing in a practical circumstance. The main reason for the growth of serious gaming is because of the amount of research that has gone into this field and proven the positive health and wellbeing benefits of the use of these games.

Serious gaming is quite often associated with games regarding education and health. Westera *et al* (2008) indicates that there is a wealth of material to support the opportunity of games used in education because of recorded positive effects on learning outcomes.

For this reason the developers were given grace to promote Dr. Kawashima's Brain Training with educational value as well as specific health and well-being benefits. When the title was released these values were relatively uncontested within the computer and video game industry.

Michael and Chen (2006) suggest that the positive effect of enjoyment and the research discoveries pointing towards positive learning outcomes are a good argument for incorporating serious gaming into children's education. To oppose this, De Freitas and Oliver (2006) counter the argument stating that educational games lack a dedicated framework and therefore cause a major impediment with respect to their application as a useful tool within a learning environment with already established teaching mechanisms.

Various authors have already pointed towards the opportunities of video games and virtual reality simulations within education with tremendous anticipation because of the positive effects in learning outcomes (Kiili, 2005; Amory, 2007).

2.3 Gaming and the curriculum

Games of different sorts have been included in the curriculum for a long time. Games have been demonstrated to instigate active learner involvement through a variety of experimentation, competition and exploration as well as directly supporting learning by challenging creativity. Games also address specific areas of information skills and problem solving skills. The obvious reasoning behind introducing video games within the education system is the enthusiasm with which many children consume video games. Children and young adults (now extending to around the age of 25) fall into a bracket of society known as "Digital Natives". Digital natives are those that have been born into or around the technological boom occurring post 1980's and have consequentially grown up at the same time as the technology (Prensky, 2001).

As the popularity of computing and IT grow so too does the incorporation of these disciplines into the education system. More children are now exposed to IT earlier than they have ever been before and as such the influence of well designed and quality educational software or "edutainment" has the potential to impact upon a vast audience.

The principle factors in this are the quality of the design and how widespread the usage of the various packages may be. For example the package may be specifically mathematics based and train children how to complete their multiplication tables. This package has focus and scope and the content is highly portable since it will remain fairly static within various institutions on a pretty much global scale with the possible affliction of language translation. On the opposing hand imagine that a piece of edutainment software has to be created to teach children about their national history. This package can still be said to have scope and focus however the content will vary massively amongst countries and therefore make the package less portable.

Taking this into consideration it can be surprising to note that with the rapid growth of the games industry over the past 26 years there is still only limited use of video games with learning potential outcome at use within educational facilities at present. The games industry and the education system, despite opportunities for correlation, have existed for the most part as two non-synchronised units with a wealth of similar goals, objectives and target audience (Westera *et al*, 2008).

Squire (2002) reports that attitudes to computer and video games are unfavourable and likely to encourage extreme and unhealthy competitiveness in children rather than well defined and considered objectives within the learning syllabus. Garris *et al,* (2002) and Ma *et al,* (2007) both note that game based learning often comes about because of extensive repetition which suggests constant re-engagement and can be seen as “low level learning”. With this in mind the brain functions used within gaming seem to be diametrically opposed to the brain functions of learning. Learning is said to be based around concentration, perseverance and involvement whereas gaming is more related to fun, relaxation and detachment however with a more in depth look at the goals of each it becomes apparent that there is far more cross over than was previously thought.

2.4 Edutainment

Wang *et al* (2007) points to the fact that as time passes the popularity of computers is ever increasing amongst the population, especially with children. Children now have far better access to computers and as such many more children are now computer literate than at any point in the past (again a point attributed to the digital native theory) and the average age of children using computers is constantly falling. Many children who have access to computers use them to play games and to study making use of technologies such as the Internet and multimedia software packages. All this points to the fact that the way children live and learn is changing on a massive scale (Druin, 2002). With the shift of computer use away from predominantly adult users to include a growing market for children it must also be argued that the suitability of software be designed with this in mind in order to maximise the potential market possibilities. As more children are using computers specifically for education then it would appear sensible for this market to be catered for. It was from this way of thinking that the concept of edutainment was originally borne.

The shift in trends from adult oriented software to child oriented software is a fairly modern development and as such the level of research, development and production up until this point reflects this by being far more weighted towards adults. Wang points out that while this shift is occurring, the highest percentage of work on software specifically aimed at children's education remains at the experimental stage.

Several major universities conduct research into children's edutainment including;

- The University of Maryland's HCI Laboratory
- MIT's Multimedia Laboratory
- Carnegie Mellon University's HCI Research Group
- Cambridge University
- University of Tokyo UI Research Group

As has been previously stated in the introduction of the report Dr. Kawashima's Brain Training for the Nintendo DS is an example of Edutainment software. Edutainment itself is a phrase used to specifically describe something that is both educational and entertaining. Edutainment software is modern branch of the computer and video games industry that attempts to provide specifically children with educational, intellectual or beneficial content delivered via the same channel as typical video games. This is achieved by distributing the software on popular video game consoles such as the Nintendo DS and utilising the specific benefits of the user interface to the advantage of the software as can be seen within Dr. Kawashima's Brain Training. Studies have shown the combination of educational content and the entertainment model to create edutainment has in recent times become far more popular than when the concept was initially attempted (Wang *et al*, 2007).

The Nintendo DS has the advantage of being both popular and novel in terms of interface interaction since the device employs a stylus or pen based input method utilising touch screen technology.

Ren and Moriya (2000) indicate in their research findings that pen-based systems such as the Nintendo DS have, since emergence upon the market, found a stable and influential foothold within the discipline of computer technology. The pen-based input method is particularly well suited to the likes of "notebook" devices (typically mobile technologies) where the user has the ability to make notes directly via the interface rather than being restricted by typical input devices such as keypads. The use of a pen device to directly manipulate the interface is seen as favourable amongst such mobile technologies. Nielsen (1994) points out that for the interface to be effective there must be instant feedback to the user in the form of a change in the display. If there is no reaction from the device or the user detects a delay of anything more than one tenth of a second the illusion of the pen and paper metaphor will be broken and the device will lose the benefits of having a pen based input mechanism.

In creating edutainment software the development team must have a basis of knowledge in the key technologies of computer science as well as a depth of understanding of psychology (particularly that relating to children), cognitive psychology and education. To break this down even further it is necessary to understand the inter-psychology between children and computers, a child's understanding of HCI (Bers *et al*, 1997), 3D models for children (Igarashi *et al*, 1999), programming for children (Pane, 1998) and the impact of cooperation on children (Druin, 1999).

Many successful examples of edutainment for children are seen specifically on the Internet. One example of this is the popular "Bitesize" service offered by the BBC. This method of delivery allows for the content to be updated suiting the needs of the user at relatively short notice. Internet deployment also allows for necessary tweaks to be made to the content in order to conform to regional, cultural and educational model variations.

2.5 Computers as learning tools

It appears relevant that certain cultural characteristics must be taken into account with regard to the involvement of computers as learning tools. This said, the mere inclusion of computers in education can be set into one of three distinct types as covered in a study by Tondeur (2007). These types are;

- Basic Computer Skills
- The use of computers as an information tool
- The use of computers as a learning tool

In this particular case study the Nintendo DS and Dr. Kawashima's Brain Training game are used as a learning tool since the user does not intend to learn anything from the use of the package however they should benefit intellectually from use of the system. In actuality grounding in all three types of usage is beneficial when dealing with learning with computers.

A predefined IT framework already working within an educational facility would seem to positively affect the outcome of a scenario based around computer oriented education and the willingness and innovativeness of the body who administers the guidelines of the work is also necessary for positive results (Tondeur, 2007).

Applications designed to attract children tend to rely heavily upon images and content that is superficially appealing to children such as an identifiable cartoon character or as is particularly relevant with Nintendo, celebrity endorsement through advertising.

Many edutainment applications fail because they do not specifically meet the needs of children or they are too complicated and fail to focus on the child psychology aspect as a guide for design and development. Although Dr. Kawashima's Brain Training was designed with an elder audience in mind, many of the staple decisions are similar to those that would be considered for creating a piece of software suitable for children, particularly young children. For instance the text should be large enough for users to read and simple enough to understand without any prerequisite knowledge. The content must be simple yet effective and to the point and the interface must be uncluttered and make no assumptions as to the level of computer literacy of the user. By creating the game specifically for an aging populous it can be argued that Nintendo have also created a game that is adequately suitable for early school age users as a learning tool with specific relevance in maths and logic. Previous endeavours that have failed have done so because they appear to have followed a very traditional HCI development method towards their design and not tailored the package accordingly.

2.6 Learning and Teaching in Scottish Schools

A common view amongst teachers seems to indicate the benefits of incorporating computers into education can become mired by the sheer novelty factor of their use. The device itself can be considered a learning tool but cannot be considered a surrogate for human teaching ability. At the heart of its operations a computer is simply a device used for the storage, manipulation and display of data. The main advantage of using a computer as a learning device is the ability to interact with and manipulate the data. This interactivity is what gives computers an advantage over traditional measures of textbooks although the feedback offered by the computer is not as dynamic as that offered by a living person and can potentially be confusing or entirely unnecessary.

The main method of teaching employed within the Scottish Curriculum appears to focus on whole-class teaching where all pupils are treated equally and taught collectively (with few minor exceptions). There have been efforts by enthusiasts for computers to be introduced to the curriculum in Scotland tracing as far back as 1982. The main reason behind the drive to get computers into schools seems to be for the advancement of self motivated learning amongst children. This self motivated approach is seen as a great method of better understanding the needs of each child as an individual and allows the teacher to tailor a more individual learning experience for each pupil they are in contact with. It was from this thinking that the Scottish Computer Education Group was formed. The group strive to integrate computers and in particular computers as a learning device into the Scottish curriculum. Although using computers within education seems like a panacea it must also be pointed out that the use of computers does come with some serious impacts upon budget, time and training. With respect to time needed to learn various functions and uses for each specific technology on the teachers' part it must be said that the more time and effort invested will lead to far greater benefits for the pupils as greater knowledge leads to greater understanding (Lee *et al*, 1983).

2.7 Computer Aided Learning

McCormick (1983) points out that most children have no preconceptions or fears regarding the use of computers. Adams (1991) suggests that this is because computers have been a staple of their lives so far and is therefore socially acceptable or normal. It would seem children find the inclusion of computers within the classroom novel and exciting and almost like a deviance from formal education.

Taking these points into account, computers can be categorised into two very specific roles within education;

1. To organise and manage learning (Computer Managed Learning (CML))
2. To assist in a provisional resource (Computer Aided Learning(CAL))

The focus of the intended use of the Nintendo DS and Dr. Kawashima's Brain Training falls more into the CAL category however the software does allow for recording and graphing of results as the package is used. Each time the daily test is completed the results are stored on the cartridge and can be recalled by the user in order to provide a visual representation of progress in terms of the users brain age scaled against time.

For this reason there can also be said to be a degree of CML at play within the software however the main focus should be on the CAL aspects.

The potential and the limitations of or CAL are defined by the combined effects of;

- Physical limitations of the intended computer system (memory capacity, input/output devices etc).
- Features of the language employed in the creation of the software.
- The specific program in use
- The way in which computer-based activities are organised in the classroom by the teacher (incorporating both direct and indirect learning).

(Lee *et al*, 1983).

The purpose of CAL is to view the computer as a resource that can be used by both teacher and pupil. The inclusion of CAL within the education system should not and cannot offer a complete replacement for the human presence of a teacher; it is optimally employed as an enhancement to the process of learning a subject. CAL focuses on individual and self motivated learning through methods of reinforcement and revision. CAL should not be used directly to teach a new concept however it can be used as a means to practice and improve an existing knowledge base through practical demonstration. This effect is achieved by allowing CAL packages to extend the normal learning environment for class, group or individual study by modelling and simulating systems and interrelationships that occur in life but normally outside the range of typical classroom investigation (McCormick, 1983).

In the case of Dr. Kawashima's Brain Training the package is used to expand the concept of mental mathematics and allows for progressive self improvement as well as giving the user an idea of specific real world benefits connected to its use. The actual content may seem relatively low brow and below the learning capabilities of most children above the age of 6 or 7 however the competition element of the game play and the ability of each child to chart their own progress and encourage self motivated learning and improvement allow for a positive argument to be attached to the possibilities the use of the package would allow in the classroom.

For a new resource to be acceptable to teachers it must be of value to the teaching of a particular topic. The resource must also be easy for a teacher and their pupils to understand and use and must cover the curriculum or enhance already grounded philosophies. It is important the resource draws from relative experience of the intended pupil however does not impinge on subjects out with the area the package is trying to cover. In the case of computers in the classroom there is no sense in using a computer simply for the sake of it, the value of the computers use must be weighed with the actual effectiveness of its use.

CAL must be versatile and adaptable to different teaching styles, pupil's needs and classroom contexts. A well designed CAL package should develop realistic involvement and rapid response. It is also suggested that good design stems from the assumption that users do not begin using a package with a preordained thought process of the packages operations. If the user can navigate and interact effectively within minutes of starting use of a new package then the design can be considered a success (Nielsen, 1994).

Good design allows flexibility to adopt the strategy into various teaching frameworks whilst still incorporating Nielsen's heuristic principles and a sense of "guided discovery".

The HCI of CAL should be kept simple to encourage first time users and also remain highly interactive to emphasise the value of the delivery method. As has been previously argued in this report, CAL within the classroom is not a replacement for a human teacher and should simply be employed as an aid to learning.

The complexities and flexibility of computers and computer packages coupled with alternative teaching methods and curriculum frameworks make them particularly unpredictable with regard to their educational effects and value. They must be considered a distance teaching device, similar to textbooks yet obviously offering a greater depth of interactivity and feedback. With this in mind it must be argued that CAL has a very strong potential to become a powerful ideological force within the boundaries of formal education if the concept of its novelty can be overcome and real depth of design knowledge is embedded within the discipline of its creation (McCormick, 1983).

2.8 Metaphors and Scenarios

2.8.1 Metaphors

Dix *et al* (2004) show that it is common practise to employ metaphors when attempting to teach a new concept to allow the user to swiftly identify with a familiar real-world situation or phenomenon. The danger involved in using a metaphor as a method of teaching the user about an interface is that the user is still expected to have a certain degree of intuition and be able to segregate the physical consequences of certain actions from the implied consequences where the metaphor cannot be specifically linked for functional or logistical reasons. An example of such a scenario could be seen within the old Apple Mac's whereby the system command to eject a disk would be to drag the icon of the disk to the waste basket. When broken down this process seems illogical as the waste basket is normally seen as an area where unwanted items are disposed of.

The Brain Training metaphor appears to be similar to that of a school lesson thus linking the suitability of the game to educational purposes. The metaphor is further enhanced by the device being held lengthways, similar to that of a notebook and the primary input device is a stylus combined with touch-screen technology which simulates traditional note-taking. This further supports the argument for using the game as a teaching device within education of children even though the game was intended for a mature audience.

2.8.2 Scenarios

Within edutainment, and video games in general, it is popular and beneficial for the creators to employ the use of scenario based design (Dai *et al*, 2002). Dai suggests that scenarios provide an excellent basis for association and as such groundings for successful communication of material to the end user as well as a better chance of the end user understanding the material. This, it is implied, is based upon the reasoning that a scenario is something which the user will be able to relate to in the real world (somewhat similar to the concept of a metaphor as previously discussed).

Scenario based design is the name given to a design methodology that was introduced by Professor Rosson in 2002 as the "Scenario-Based Usability Engineering Model" and specifies that scenarios be considered a central artefact within system and software design. With this said, Professor Rosson failed to provide a description of how to use scenarios in the evaluation phase of the software lifecycle.

Scenarios are stories about people and their activities. Scenario based design is a term given to the methodology of considering the scenario as the central artefact within system design. This approach encourages user involvement at the design stages and also benefits by providing shared knowledge and information amongst those concerned with the system development. Scenario based design helps envision uncertain future tasks within the development and also enhances the ease with which user centred instructional material can be produced (Go *et al*, 2004).

The earliest successful application of scenario based design recorded was the voice messaging system developed by IBM for the Los Angeles Olympic Games in 1984 (Jacobson *et al*, 1992) and has since been implemented successfully in a number of software development projects.

In HCI, scenarios are used to describe detailed context to facilitate with the decision making process at the design phase. In software engineering scenarios are seen as instances of use cases (Potts *et al*, 1994) and requirements engineering uses scenarios to record observance and analysis by the user and it is from these observations that the requirements are drawn.

Interface scenarios describe the process of user tasks in detail using both text and images. This helps the user to understand the future system by giving them an intuitive description and also facilitates communication between the designers and the users.

A scenario based usability evaluation method for software uses multiple scenarios to evaluate a piece of software. The method includes 3 stages;

1. Training – where the interface scenario is used to design the training document, test predetermined user missions and let the user understand the software usage and learn it in a short time.
2. Testing – where scenarios are used to record and analyse operation conditions in order to find problems of software and the preference of the user.
3. Analysis – where any revisions can be suggested, these are then implemented and the evaluations continue as an iterative process until the optimal results are achieved or all possible actions are exhausted.

2.9 Nielsen's Heuristic Evaluation Guidelines

Jacob Nielsen (1994) outlines the concept of heuristic evaluation as a realistic evaluation method for HCI. Heuristic evaluation is referred to as discount usability engineering and is viewed as a quick, cheap and easy evaluation method as well as being considered one of the most popular usability inspection methods due to its systematic inspection of interface design with regards to human usability.

Heuristic evaluation takes place by looking at something and the way in which it performs by weighing up the good and bad aspects of that particular application in a specific context. Nielsen also insists that through testing a live project rather than a static representation of one that more realistic and relevant user feedback is discovered.

The primary goal of heuristic evaluation is to discover usability issues that arise that can be directly attributed to design problems. The best stage within the software lifecycle model to employ the heuristic evaluation method is during the iterative design phase however for the purposes of assessing user satisfaction and usability issues the process is also well suited to evaluate Dr. Kawashima's Brain Training as a learning tool for children in primary education.

To perform a successful heuristic evaluation it is necessary for there to be several users present as each user can provide a different insight as to how the overall package is perceived. This follows the theory that what is a problem for one user may not be for another therefore the frequency with which problems arise during the evaluation allows for the evaluator to place design issues in some order of precedence. For an extensive yet balanced result then approximately 10 users are needed.

The process of evaluating the interface involves each evaluator examining alone and taking note of personal findings before being allowed to discuss these findings in a group environment. This particular method is important in order to keep findings as independent and unbiased as possible (Nielsen, 1994).

Nielsen and Lauder indicate that usability testing with a single participant will reveal approximately 42% of all major usability issues and 32% of all minor issues.

2.9.1 Nielsen's Usability Heuristics

Nielsen indicates 10 separate usability heuristics within the guidelines for evaluation he created;

1. Visibility of system status

   The system should always keep users informed about what is going on through appropriate feedback within a reasonable time. With regards to Dr. Kawashima's Brain Training on the Nintendo DS this could mean ensuring the user knows when they are required to interact and when they are required to follow instructions.

2. Match between the system and the real world

   The system should speak the user's language using words, phrases and concepts familiar with the user rather than using system oriented terms. Since the delivery platform is a games console designed primarily for children and younger users this should not be a problem with the Nintendo DS. The system should also follow real world conventions, making information appear in a natural and logical order.

3. User control and freedom

   User's often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. This simply means that user's must be able to undo any action they do in error such as selecting the wrong section of the game or entering the wrong data to answer a question.

4. Consistency and standards

   Users should not have to wonder whether different words, situations or actions mean the same thing. There should be strict and rigorous platform conventions that are adhered to at all times.

5. Error prevention

   Prevention is considered better than good error messages. Good design prevents problems from arising in the first place.

6. Recognition rather than recall

   Objects, actions and options should all be made visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable wherever appropriate.

7. Flexibility and efficiency of use

   Accelerators – unseen by the novice user – may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. This is less likely to be an issue with a video games console since most of the actions are standard. There is the possibility of shortcuts that could be used to speed up user operations.

8. Aesthetic and minimalist design

   Dialogues should not contain information that is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

9. Help users recognise, diagnose and recover from errors

   Error messages should be expressed in plain language and precisely indicate the problem and constructively suggest a solution.

10. Help and documentation

    It is preferred that a system can be used without it, it may be necessary to provide help and documentation. Any such information should be easy to search, be focussed on the user's tasks, list concrete step by step instructions and not be too large.

The system should always keep the user informed about what is happening at any particular time and appropriate feedback should be given to the user to convey this in a manner that is both logical and acceptable. In order to achieve this package must understand the specific needs of the intended user group. The system must also follow acceptable real world conventions and present information in a natural and logical fashion.

2.10 Children and usability evaluation

Whilst attempting to judge the effectiveness and usability of Dr. Kawashima's Brain Training in this project it is apparent that several factors must be addressed including areas of child psychology, cognitive response and user effective design.

Studies have shown that the basic usability features of children's software fall into three separate categories;

- Instruction
- Activity
- Layout

(Druin, 1999).

These categories should be used as the headings within the evaluation tool for evaluating the usability of Dr. Kawashima's Brain Training.

It is logical that these must become the focus of the measurement of immersion and enjoyment in order to fully assess the effectiveness of the HCI employed in the software.

Activities must be of interest and challenge the user to keep them engaged while promoting a reasonable learning curve and never allow the child to feel they are being talked down to nor left without an understanding of what is asked of them.

Instructions must be suitable for the age of the user and offer relevant understanding. If the child is made to feel stupid or baffled then the instructions are not suitable. If the child is able to navigate the system solely through instruction they are a success.

Layout must be simple yet efficient. The user must be allowed some level of intuition and the positioning of icons and cursors within the interface must seem logical and organised to the user.

2.11 Observation Techniques

Nielsen outlined several inspection methods throughout his body of work. One of these methods is known as cognitive walkthrough (also sometimes known as think-aloud). "Think aloud" is where the user talks through the process they are undertaking and vocalises their decision making process. This method is simple and requires little to no expertise to conduct and theoretically should produce a realistic depiction of the users thought processes and reaction to on screen stimulus however the observation part of this method can lead people to become far more self conscious of their decisions producing a distorted version of the natural thought process. This is referred to by Nielsen as "Playing up for the cameras" where the user says what they think they are required to say as opposed to what they actually think.

Cooperative evaluation is where the user is encouraged to view themselves as collaborators in the evaluation and not a test subject being personally evaluated. The main benefit of this method is that it encourages criticism by removing pressure from the user and focuses more on the shortcomings of the system.

A post-task walkthrough can add depth to the cognitive walkthrough and offers an insight to optional choices and reasoning behind the paths chosen by the user. A delayed walkthrough allows for the user and the evaluator to consider questions.

2.12 Memory Types

Essentially there are three different types of memory;

- Short term (or working)
- Long term
- Sensory buffers

2.12.1 Sensory Buffers

Sensory buffers are the initial memory location where stimuli are received via the various senses (iconic, echoic, haptic) and are constantly overwritten. The sensory buffers pass this information to the short term memory (STM) via the medium of attention. Attention is the name given to the focus of a singular object from the multiple stimuli or thoughts competing at a specific time. Attention itself is controlled semi-independently and is governed by interest, arousal or necessity.

2.12.2 Short Term Memory

Short term memory provides a retention area for thoughts and a temporary recall of information. It is also in the short term memory that mental calculations and comprehension of read items occur. STM can be considered as a rapid access memory source however it also has a rapid decay element as well. Memory works on a stack basis and the more items introduced to the STM the quicker the older items are pushed from the stack. STM also carries a limited capacity for recall so when the limit is reached and an item is pushed from the stack, the thought is either discarded or transferred to long term memory (LTM). Miller established that the average capacity for human STM is 7+/- 2.

STM performs a function known as “Chunking” whereby data is formed into clusters or chunks that are easier to remember than the individual component components. This is performed as the memory has a natural ability for self optimisation. The successful formation of each chunk is known as closure and upon closure the STM flushes and the next task is processed.

2.12.3 Long Term Memory

Long term memory (LTM) has a far greater capacity than STM however also has a slow access rate. LTM can also be said to have slow decay. LTM can also be further refined into episodic memory which refers to events and experiences stored in a serial format or semantic memory which is a saturated record of facts (e.g. a network). It is through a combination of structure, familiarity and concreteness that information can be stored in memory and easily recalled. This is the physical breakdown of the learning process.

The reason people forget can be attributed to memory decay and interference. As reported in Nielsen, an experiment by Ebbinghaus concluded that information decays in a logarithmic fashion. This means that a single thought begins to be lost rapidly yet the decay slows with time until the thought is completely lost.

2.13 Conclusions

Through this research a case has been brought for and against the inclusion of interactive multimedia as an educational tool. The general appeal for innovation seems to warrant the progress of teaching methods to include the use of technology as a delivery platform for certain areas of the standard curriculum. In contrast, traditionalist methods appear to have worked well therefore excusing the necessity for a transfer of delivery methods. The main decision to implement such teaching methods will rely upon extensive research and yet at this stage in time it can be pushed as potential advancement to traditional teaching methods with an emphasis on self regulated learning amongst pupils.

3. Methods

This section shows what methods were employed in the undertaking of the project and the construction of the primary research methods as well as an overview of the Dr. Kawashima's Brain Training game itself.

A combination of experimental methods and case study techniques were used in the course of this project. The experiment was predetermined by a third party and the project itself did not involve any deviance from the already devised challenges and tasks set.

The experiment revolved around a class of 23 pupils from a primary school in North Ayrshire, referred to as school X for the duration of the project. School X is declared as a mixed school of non-denominational religion. The pupils were all of equivalent level Key Stage 2 and had a level of maths of either D or E.

3.1 School Case Study

A class of pupils within school X had been chosen as the subjects of the case study due to their participation in an experiment as mentioned in the introductory chapter of the report. The experiment involved the use of Dr. Kawashima's Brain Training as a learning device within a primary school. The pupils had taken part in a pre-test examination and results recorded. The results of this test were made available for the purposes of research however the administering body did not release specific detail of the content of the test itself.

The children were required to dedicate 15-20 minutes of lesson time to using Dr. Kawashima's Brain Training and during the study 6 of these children were asked to complete the task by providing a cognitive walkthrough in order to attempt to observe and record usability. Before selecting the children to conduct the cognitive walkthrough it was important to first talk to the children so that a variety of opinion would be gathered via the evaluation. This selection process along with gradual introduction to the classroom was used to attempt to normalise the conditions and so the children became familiarised with an extra person in the classroom and the reason for being there. Each walkthrough took place on separate days to avoid confusion of results collected.

The 6 children selected to perform the cognitive walkthrough were also selected to perform a post-task walkthrough that took the form of a structured interview. Although Nielsen indicates in his research that questionnaires are the most appropriate method of data gathering this technique did not consider that children would be the main user group. In order to gather appropriate data the questionnaire was created to be utilised as a structured interview strategy. By using an interview instead of a questionnaire it was hoped that the users could be encouraged to expand upon their answers and if necessary the questions could be re-phrased to suit the user. The interview was created using Nielsen's usability heuristics as a guideline and attempted to focus appropriate usability heuristics directly to the use of Dr. Kawashima's Brain Training on the Nintendo DS. The same structured interview was also utilised in evaluating the teacher's feelings on the use of the game as a teaching device.

In an attempt to further expand on the user evaluation 9 more questions were created based upon the three sections of Druin's user evaluation. These sections were headed Activity, Instruction and Layout as detailed previously in the report. Each section was evaluated against three

separate factors, effort, usefulness and satisfaction in order to ascertain specific user feelings with regard to the HCI and usability of the game.

Appropriate measures were taken to ensure all legal and ethical issues were addressed before access could be granted to the school. Special care had to be taken considering the user group to avoid complication.

3.2 Expert/Teacher Evaluation

Prior to entering the classroom several meetings took place with the teacher of the class used in the study. The purposes of this were to gain an understanding of the teaching methods employed by the teacher and to gain an insight into their personal opinion on the use of Dr. Kawashima's Brain Training within the classroom.

The teacher involved also discussed the way in which the package was used within the classroom and the times when the results were most encouraging and what the feedback she had received from her pupils had been.

The teacher evaluation took place over a series of interviews occurring prior to, during and post involvement in the case study.

3.3 User group evaluation

The main user group for the case study were concluded to be children within primary education of Key Stage 2 or equivalent. The HCI evaluation took place involving the children from school X and was conducted over the space of one week. 4 children had been selected, one male and one female pupil who both were seen as "progressing as expected" by the teacher and one male and one female who were both seen to struggle with the material. This selection was made for the variance in opinion of the software and using cognitive walkthrough the HCI was evaluated from a user perspective. For reasons of comparison, two pupils from a separate class were asked to complete a daily walkthrough of the game and also evaluated using the same interview structure. These two pupils had used Dr. Kawashima's Brain Training the previous term and were chosen as a comparative measure to find out if the absence of the game from their regular studies affected their feelings and to measure how well the pupils remembered the standard operations after an extended period of not using the game. The cognitive walkthrough was used to allow the users to explain in detail their likes and dislikes of the package.

- Pupils A and B were both in the category of "progressing as expected".
- Pupils C and D were both in the category of struggling with the material.
- Pupils E and F were from the class that had not recently used the game in class.
- Pupils A, C and E were male.
- Pupils B, D and F were female.

3.4 Data gathering techniques used for the report

A combination of data gathering techniques was considered most appropriate for evaluating the HCI of Dr. Kawashima's Brain Training with a primary user group of children. The methods chosen were seen to fully utilise task scenarios in order to stress the user's cognitive processes. Essentially these methods put the focus on the user and recognise the specific user goals (Nielsen *et al,* 1990).

The use of Nielsen's usability heuristics was considered important as they are recognised evaluation guidelines within the area of HCI.

The use of the Druin's children based user evaluation was considered important by focusing the results on the intended user group.

The use of a cognitive walkthrough is important as it can give a valuable insight into the user's mindset when they are actually using the software package.

By using a combination of data gathering techniques it was expected that the information gathered would become substantially reinforced.

3.5 Interview/questionnaires

Nielsen (1994) indicated that the most effective way to measure user satisfaction is to employ the use of questionnaires. With the small scale of this project and the target user group consisting of children the use of questionnaires was replaced with interviews to gain valuable feedback from the users. The interviews were used to discover issues arising from the use of the software and the cognitive process of path decision. The interviews took a semi-structured in order to tailor them towards the individual users and also to guide users to discuss the appropriate areas that were being evaluated.

3.6 Nielsen's Usability Heuristic Interview/Questionnaire

The questionnaire for the evaluation was derived directly to correspond to Nielsen's Usability Heuristics. Although the heuristics are not centred directly on the evaluation of children's software it can be adapted to connect directly to Dr. Kawashima's Brain Training. The following questions are included to gain the information needed.

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

Question 1 covers the heuristic "Visibility of system status". The purpose was to discover is the game kept users informed and if the information was appropriate and delivered in reasonable time.

2. Could you see a purpose in what you were doing?
3. Could you relate it to anything else you have done in class?
4. Could you relate it to anything you do out of class?

Questions 2, 3 and 4 relate to the heuristic "Match between system and the real world". This is used to discover if the system speaks the users' language using words, phrases and concepts familiar with the user that they are comfortable with. These questions are also used to see if the game follows conventions seen in the real world and presents information in a natural and logical order.

5. What did you think about the stylus and touch screen input?

Question 5 is used to discern "User control and freedom". Used to discover how the users felt about the interactions with the game.

6. Did it feel like you were learning a lesson or playing a game?
7. How much attention did you pay to Dr. Kawashima?
8. Do you think he is a good character for a game?
9. Did you know he was a real person?

Questions 6 – 9 are rather more general and do not relate directly to one usability heuristic, rather they cover a range and are designed to discuss the users enjoyment and understanding of the game.

10. Do you know any "cheats" to get the results you wanted? (workarounds/loopholes)

Question 10 is used to discuss the "Flexibility and efficiency of use". The purpose of this question is to see how well the users knew the layout and the operations of the game and if they had figured out any shortcuts within the game.

11. Did you like the look of the game?
12. Was it ever overwhelming playing the game?

Questions 11 and 12 both cover "Aesthetic and minimalist design". The dialogues should not contain information that is irrelevant or rarely needed. This in theory should help with the flow for the user and keep them interested in using the package.

13. Did you make any mistakes?
14. If yes – did you realise you had made a mistake?
15. If yes – did you know what you had done wrong?
16. If yes – did the game show you the right way to perform the task?

Questions 13 – 16 all fall into the bracket of "Help users recognise, diagnose and recover from errors". The error messages should be expressed in plain language and constructively suggest a solution.

17. Did you read the instruction book?
18. Did you know what to do?
19. Did you need to help anyone else in the class?

Questions 17 – 19 are used to evaluate "Help and documentation". Even though it is best if a system can be used without documentation it may be necessary to provide help and

documentation. This information should be easy to search, focused on the users task, list concrete steps to be carried out and not be too large.

20. Did you enjoy the game?
21. What did you like most?
22. What did you like least?
23. Would you play the game outside of class?
24. If yes or no – Why?
25. What could make the game better?

The final 5 questions were used as a method of understanding the users enjoyment and immersion with the game and any relevant changes that they felt could have been made.

The results of these can be found in appendix A to G

3.7 Druin's Usability Evaluation

In order to assess the levels of usability as previously outlined in the report it was decided to use Likert scaling to evaluate the usability as outlined by Druin (1999). The areas that needed to be assessed were;

- Activity
- Layout
- Instruction

Each of these levels was measured in terms of effort, usefulness and satisfaction by asking the pupils to rate the different section out of 5.

The questioning for this section was set out as follows;

- Activity

  Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult 3 – Normal 4 – Easy 5 – Very Easy

  Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal 4 – Important 5 – Very Important

  Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal 4 – Happy 5 – Very Happy

- Layout

  Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult 3 – Normal 4 – Easy 5 – Very Easy

  Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal 4 – Important 5 – Very Important

  Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal 4 – Happy 5 – Very Happy

- Instruction

  Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult 3 – Normal 4 – Easy 5 – Very Easy

  Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful 3 – Normal 4 – Helpful 5 – Very Helpful

  Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy 3 – Normal 4 – Happy 5 – Very Happy

The results of these can be found in appendix H to N

3.8 Description of Dr. Kawashima's Brain Training

The software employed for use within the classroom of school X was, as has already been disclosed, Dr. Kawashima's Brain Training. The software uses aspects of simple mathematics, English and scenario-based problem solving. An example of the scenarios employed within the package can be seen in the task where users are asked to keep count of people entering and exiting a house

On first use the user is invited to add a signature as a tag to their account within the game. The game can store four separate accounts per cartridge and encourages multiple users in order to maximise the use of the package.

Within the scope of spending 20 minutes using the package, the user is likely to encounter a combination of the following tasks;

- Calculations X 20 – where the user completes 20 simple mathematics questions as quickly as possible. The questions can include addition, subtraction, multiplication and division.
- Calculations X 100 – similar to the above scenario although 100 questions.

- Reading Aloud – Where the user is invited to read a passage of text out loud
- Low to High – where the user is presented a flash of a set of numbers in a sequence and the user is asked to remember the order once the sequence has been hidden from view.
- Syllable count – where the user must enter the number of syllables in a sentence or phrase given to them
- Head Count – where the user is asked to follow the number of people entering and leaving a house.
- Time Lapse – where the user is presented with two analogue clock faces and asked to calculate the time difference between the two.
- Triangle maths – where the user is asked to perform a series of simple maths equations based around a concept the game teaches them.

On top of this the user is asked to complete a "Brain Age Check" which combines 3 tests;

- Number Cruncher – where the user is asked to answer questions based on factors surrounding a collection of numbers presented to them.
- Number Maze – where the user is asked to use the stylus to join letters and numbers in a given order.
- Word count – where the user is presented with 32 words for the space of 2 minutes and is asked to memorise these words. They are then asked to write as many of these words as they can remember in a further 3 minutes.
- Stroop Test – where the user is presented with a variety of colour names on the screen. The text is also of various colours and does not always match the colour of the font (i.e. text reads "red" but is actually coloured blue). The user must speak the colour not the word directly into the microphone.

The results of these three tests are calculated internally to provide the user with their appropriate "Brain Age".

4. Results

This section of the report sets out the results gathered from the interviews with both the primary user group and the teacher of the class involved in the experiment. The section also displays the findings using various graphs and charts.

4.1 Cognitive Walkthrough

When it came to the users performing a cognitive walkthrough or "think aloud" evaluation it became apparent that by attempting to talk through their cognitive processes each user was falling into the category that Nielsen refers to as "playing to the camera" where they were simply saying what they thought they had to say.

During the first cognitive walkthrough, Pupil A performed the system startup and login without discussing what the tasks they were performing. After being prompted to explain the thought process behind the tasks being completed, Pupil A responded that they had not thought about anything yet and simply performed the tasks the same way every day. When the pupil did explain the choices being made it appeared to distract the user in a way that could be considered to interfere with results. A similar scenario occurred when attempting the second cognitive walkthrough and for this reason the cognitive walkthrough had to be declared as erroneous and the results gathered were discarded from the report for the same reasons.

This left the questionnaire/interview based upon Nielsen's usability heuristics and the Lickert objects based upon Druin's usability evaluation as the main sources of data collection.

4.2 User group results

The responses to question 1 were used to evaluate the "visibility of system status". All six users responded positively to this question. This indicated that overall the users were fairly certain when the system required them to interact with it and what the status of the system at any given time was and can therefore be considered to successfully adhere to this heuristic.

The responses to question 2, 3 and 4 were used in order to evaluate the "match between system and real the world".

Question 2 was used to discover if the users could see a purpose in what it was they were actually doing. Four of the users said they could see a purpose in what they were doing and two said they did not see a purpose. Of the four users who answered yes to the question, two thought the purpose of the game was to answer questions quickly to get a good score and one thought the purpose was to help with mathematics. One user that answered yes had been in the class that were not currently using the game and responded that they could not see a purpose at the time of using the game but afterwards realised that it had helped with his mental arithmetic skills. The two users that responded no said that they could see no purpose other than being allowed to play video games in class.

Question 3 was used to discover if the users could relate the game to other classroom activities. Five of the users responded negative to this and two responded positive. All of the users however indicated that the arithmetic was the important factor of the game and two of the users

who had responded negatively also indicated that they recognised the game that required them to tell the time on an analogue clock.

Question 4 was used to discover if the users could relate the game to extracurricular activities. Five users indicated that they could directly relate the usage of the package to extracurricular activities and two responded negatively. Of the five that responded positively, three of these indicated they linked it to playing video games and two indicated that they used tips from the game to perform metal aerobics. One of the negative responses indicated that even though they could not directly relate the use of the game to anything outside the classroom they did not see this as a downfall and indicated that by keeping the game oriented on classroom activity it retained its educational value.

The response to question 5 was used to discover "User control and freedom" by discussing the stylus control and the touch-screen technology. Every user responded positively to this question however one user also pointed out that there was an issue with handwriting recognition. It is interesting to note that a later question dealing with error drew similar negative responses to the handwriting recognition tool yet only one user pointed that out when asked this question. Two users commented on enjoying the data entry method and two users indicated they liked not having to remember button combinations. One user indicated their experience being enhanced by being allowed to use the system left handed.

Questions 6, 7, 8 and 9 did not fall directly into the bracket of a single usability heuristic but were more general questions relating to usability and user enjoyment.

Question 6 asked if the users felt like they were playing a game or learning a lesson. Two users stated that to begin with it had felt like a game but as time passed in the initiative it began to feel more like a lesson. One user stated that it felt like a lesson but one that they controlled the content of which was positive. One user commented that it felt like a balance between the two answers, never feeling entirely like a game (and comparing it to the Professor Layton game also for the Nintendo DS) and it never felt entirely like a lesson because of the control they retained over the material. One user responded saying that they considered it to be more of a game than a lesson. The main reason given for being unable to disconnect from the game aspect of the package was the platform on which it was presented.

Question 7 asked the user how much attention they paid to Dr. Kawashima's avatar present in the game. Three users responded that to begin with they paid a lot of attention to the avatar's instructions yet their interest in what he had to say declined as time progressed, mainly due to repetition of information from the character. Two of the users noted that they had found the tips the character had presented to them were useful both within the game and in the outside world. One user mentioned that they did not like the character at all and found him to be boring and repetitive.

Question 8 asked the users whether they thought that Dr. Kawashima is a good video game character. Three of the users simply responded that he was "Okay" as a character. Only one user gave a definitive positive response and one user described him as "Boring".

Question 9 did not derive any information deemed beneficial for the purpose of the report from the users.

Question 10 was based loosely upon the heuristic "flexibility and efficiency of use". The responses to this question showed that only one user figured out a possible glitch within the system. No other users had looked for shortcuts or workarounds and had approached the game in a linear fashion. One user had responded that the game allowed you to pick and choose which sections were completed every day and did not require to be completed in a particular order.

Questions 11 and 12 were used to evaluate the heuristic of "aesthetic and minimalist design".

The responses to question 11 indicated that all of the users were positive to the aesthetics of the game design. Two users commented positively on the use of graphs to chart user progress throughout the time they were using the game. Two users indicated that the design of the game reminded them of textbooks they have used in class previously. One user commented they thought the design was okay but a little boring.

The responses to question 12 indicated that none of the users found the use of the package overwhelming and that there was a good learning curve employed. Different users indicated issue with particular sub games within the main package however the overall consensus seemed to point to the fact that the more the game was played the easier it became and therefore there was incentive to return to the package on a daily basis.

Questions 13, 14, 15 and 16 all cover the usability heuristic of "Help users recognise, diagnose and recover from errors".

The responses to question 13 indicated that six of the users considered they had made mistakes in the game however four of these users attributed the mistakes to system error due to poor handwriting recognition and one user indicated failures with the voice recognition system. One user indicated working around this issue by changing their handwriting and two of the users indicated frustrations with these failures. One user indicated that they did not consider they had made mistakes.

The responses to question 14 were used to discover whether the users realised they had made a mistake. Four users said they did recognise when they had made a mistake but did not always attribute it to their own fault. One user simply responded yes and two users said they were not always certain if they had made a mistake.

Question 15 was used to discover if the user knew what they had done wrong if they had produced an error. The answer was deemed not applicable to three of the users due to previous answers. One user response indicated that the main issue was with the handwriting and indicated that they had to change the way they wrote to fix the error. Three users answered that they only knew some of the time why they had produced an error.

Question 16 was used to discover if the system produced satisfactory error messaging by asking the user to explain if the game explained what they had performed incorrectly if they had incurred an error. Five users indicated that the game would provide the user with an incorrect response and then continue without explaining what had caused the error response. One user simply commented that there was no way to check what they had done wrong if they had produced an error. One user's response was deemed non applicable due to previous response.

Questions 17, 18 and 19 were used to evaluate the usability heuristic of "Help and documentation".

Question 17 asked the user if they had read the instruction manual for the game instead of simply relying on in game instruction. Four users indicated that they had not read the instruction manual. One user commented they had read the manual thoroughly and one user indicated they had read the manual a little but not in depth.

Question 18 asked the user if they understood how to operate the game. The purpose of the question was to discern which users had used instruction and which users had used intuition to operate the game. Five of the users indicated that by playing the game they learned how to use it relatively quickly. One user indicated that the most complicated process was remembering how to play the various games.

Question 19 asked the user if they had assisted anyone else in the class and was used to discover the degree of cooperative gameplay and competition that was evident. All users responded positively to this question. Four users indicated that they had helped other users. Two users indicated that they had been helped by other users. Two users indicated that at first they relied upon the teachers assistance however soon moved to peer oriented discussion. Two users mentioned the post task discussion that occurred to highlight progress and shortcomings.

Questions 20, 21, 22, 23, 24 and 25 were again not directly related to a single usability heuristic but were more centred on understanding usability and enjoyment of the user in general by touching on several of the heuristics.

Question 20 asked the user if they enjoyed playing the game. All seven users indicated that they had enjoyed playing the game. Three of the users referred to the game as "fun". Two users commented that they had started to become a little bored of the game as time passed. One user indicated that it was important to play the game regularly to keep their score high. The teacher's response indicated that playing the game was addictive and encouraged users to return regularly.

Question 21 asked the user to comment on what they liked the most about the game. One user commented that they liked the way the game charted user progress and could be followed throughout play. One user commented on being able to use the game left handed. One user commented on being able to tailor the experience to suit their needs. Three users commented they enjoyed playing video games in class. Two users commented they enjoyed the personal touched the game delivered. The teacher's response was that it was very positive to have a video game that assists with learning outcomes and is proven to have health benefits.

Question 22 asked the user to comment on what they liked least about the game. Two users mentioned they found certain tasks in the main game difficult to understand or perform correctly. Two users indicated they did not like having their brain age peak before the top limit. One user commented they did not like having to change their handwriting to suit the game. Two users indicated they thought the game became boring after a length of time.

Question 23 asked if the user would use the game outside the classroom. The reason for this question was to discover if the user group enjoyed the game enough to actively participate rather than passively participate. Four users indicated they would play the game outside of class.

One user indicated they already do play the game outside of class. One user indicated that at first they wanted to but changed their mind after a period of time.

Question 24 asked why the user would or would not play the game outside the classroom. Two users indicated that they would not play the game outside class because they considered it to be boring. Two users indicated that playing the game was too similar to schoolwork to encourage them to play it outside of class. One user produced the same response but in opposition to the previous they found this to be a positive aspect of the game by stating that it helped with school work.

Question 25 asked for user input in what could make the game better. Three users indicated that they would have preferred more games in the package. Two users indicated that it could be improved by adding a story to the game. Two users commented that they would like some degree of feedback with regard to getting answers wrong within the game and that this could be improved further if the game pointed the user towards sections that would benefit them rather than leaving the learning entirely up to the user.

4.3 Teacher's Evaluation

Question 1 was used to evaluate the "visibility of system status". The user's response indicated that the layout of the interface was good and that it was always obvious when the user was supposed to interact and when they should be following instructions. At no point during the course of the experiment did the user have to confirm to the children when any aspect of system status.

The responses to question 2, 3 and 4 were used in order to evaluate the "match between system and real the world".

Question 2 was used to discover if the user could see a purpose in the tasks they were expected to complete. The user's response to the question could have fallen into either bracket. At first the answer was no because the user felt that the introduction of video games in the classroom could be potentially disruptive. The response also indicated that the user felt the enjoyment factor of introducing the game could be a benefit when the enthusiasm of the children was displayed.

Question 3 was used to discover if the user could relate the game to other classroom activities. The user's response indicated that the maths used in the game was quite low level compared to what the children were used to however they were not used to having to answer the questions as quickly as the game required them to. The user also indicated that certain class activities since introducing the game to the classroom had been directly influenced by content from the game.

Question 4 was used to discover if the user could relate the game to extracurricular activities. The user's response indicated that the children would only relate the usage to playing video games which is correct when analysing the results however the user saw this as a negative quality when most of the children saw this as a positive quality.

Question 5 was used to discover "User control and freedom" by discussing the stylus control and the touch-screen technology used in the game. The user's response indicated that it was a good

alternative method of interaction to what had been used in class before and enjoyed the personal touches of allowing the children to have their own signature as a file name.

Questions 6, 7, 8 and 9 did not fall directly into the bracket of a single usability heuristic but were more general questions relating to usability and user enjoyment.

Question 6 asked if the user felt like they were playing a game or learning a lesson. The response indicated that the children considered the exercise to be more of a game than a lesson. The main reason given for being unable to disconnect from the game aspect of the package was the platform on which it was presented.

Question 7 asked the user how much attention they paid to Dr. Kawashima's avatar present in the game. The user's response indicated that the avatar was very useful within the game and felt that the sense of humour portrayed by the character kept him funny and refreshing to the children who were expected to treat him as a tutor.

Question 8 asked the user whether they thought that Dr. Kawashima was a good video game character. The user liked the positive health message that Dr. Kawashima promoted and indicated that it was a positive use of a video game however also indicated that while he was a good character the children would not associate him with video gaming the way they did with other recognisable video game characters like Super Mario or Lara Croft.

Questions 9 and 10 did not derive any information from the user deemed beneficial for the purpose of the report.

Questions 11 and 12 were used to evaluate the heuristic of "aesthetic and minimalist design".

Question 11 asked the user whether they liked the look of the game or not. The user indicated they felt the look of the game was simple and easy to follow. This was considered positive in keeping the material presentable to the children and keeping their attention focussed upon the tasks they had to complete

Question 12 asked the user if they ever felt overwhelmed playing the game. The user's response indicated that at no point did they feel overwhelmed by the material. There was seen to be a good pace of work and simple mechanisms that could be used to chart progress. The only issue the user raised with this question was that the speed at which the children were encouraged to answer the questions at to get a good score. This led to concern but was accepted as being a functional aspect of the game.

Questions 13, 14, 15 and 16 all cover the usability heuristic of "Help users recognise, diagnose and recover from errors".

Question 13 asked the user if they had made mistakes in the course of using the game. The user's response indicated that there were issues regarding the handwriting recognition of the console and that this led to frustration and even hindered progress within the game. The user also indicated that the game had not been "crashed" by any of the children and that the game worked efficiently and there had been no issues with the console other than the handwriting recognition and the voice recognition.

Question 14 asked the user if they realised they had made a mistake. The user's response reinforced the answer to question 13 and indicated that the mistake was not always necessarily due to user intervention and was merely a failing of the hardware.

Question 16 asked if the game provided assistance on the correct way to perform tasks if an error had occurred. The user indicated that there was no guidance on how to adapt handwriting so the game could recognise the correct input. Also the user indicated that if an answer was entered incorrectly the system did not provide assistance or explanation but would simply respond letting the user know they had answered incorrectly.

Questions 17, 18 and 19 were used to evaluate the usability heuristic of "Help and documentation".

Question 17 asked the user if they had read the instruction book for the game. The user's response was that they had been thoroughly briefed prior to using the system and that this had included being talked through the instructions in order to ground and understanding in how the game operated. The user also indicated that not all the children had read the instruction manual and that this did not present a noticeable difference in performance between those that had read the manual and those that relied on in game instruction and intuition.

Question 18 asked the user if they intuitively knew how to use the game. The user's response indicated that this was not entirely appropriate having been fully briefed on the use of the game prior to using it.

Question 19 asked the user if they needed to help anyone else in the class. The user indicated that at first some of the children were a little confused but not to any great extent. Initially the children had asked the teacher for help however after a while they relied more upon each other for assistance. This, the user indicated, allowed for a more observational approach to the classroom than an instructive role. The user also indicated at this point that the children treated the exercise as a deviance from the normal classroom routine and as such were a little more enthusiastic about the whole project than they have been about previous computer based exercises.

Questions 20, 21, 22, 23, 24 and 25 were again not directly related to a single usability heuristic but were more centred on understanding usability and enjoyment of the user in general by touching on several of the heuristics.

Question 20 asked the user if they enjoyed using the game. The user indicated that they had enjoyed using the game.

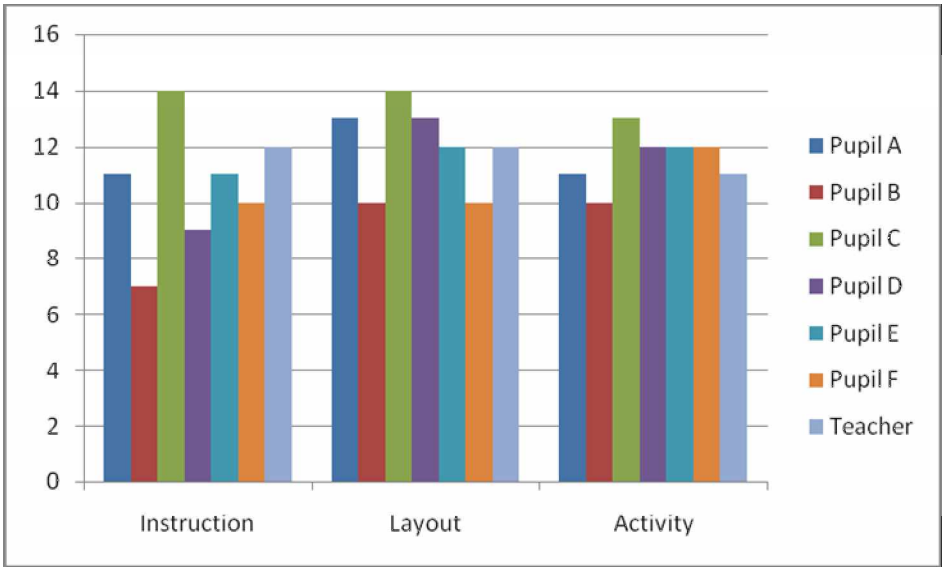
Question 21 asked the user what they had liked the most about using the game. The user indicated that they liked the concept of a video game that incorporated learning and health benefits. The user also indicated that any teaching device that could grab the attention of the children was a positive thing and the concept should be embraced.

Question 22 asked the user what they liked the least about the game. The user indicated that the material used in the game was very limited and after a while it became apparent that many of the children were losing interest in the game as time pressed on.

Questions 23 and 24 did not derive any information from the user deemed beneficial for the purpose of the report.

Question 25 asked the user what they think would make the game better. The user indicated that the inclusion of updatable material and also an extension to the areas of the curriculum covered in the package would increase its usability within the classroom. It was also indicated that different ways to capture the imagination of the children needed to be employed to keep interest levels high.

4.4 Druin's Usability Evaluation



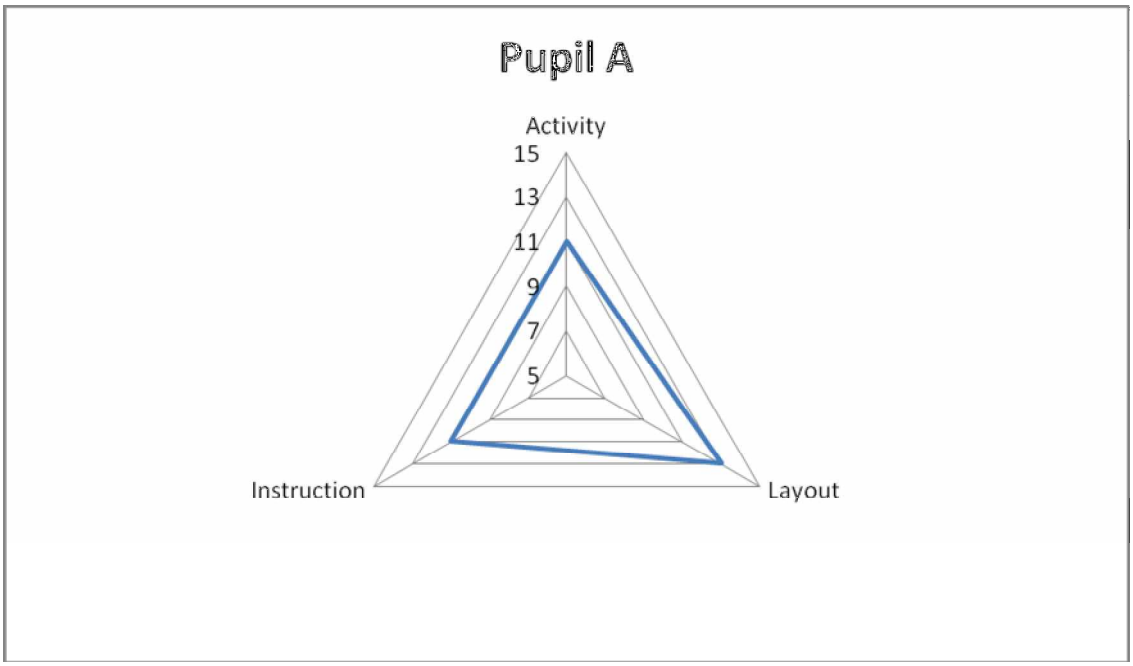
Scores were tallied using the results from the Lickert objects based upon Druin's usability evaluation. Each scale ranged from 1 to 5 with one being the lowest score possible for each section and 5 being the highest. The scores for the three separate areas of evaluation were calculated from the results of the three questions asked to the users.

The greatest variance in response fell into the instruction section. The lowest score was 7 and the highest score was 14. The average score in the instruction section was 10.5

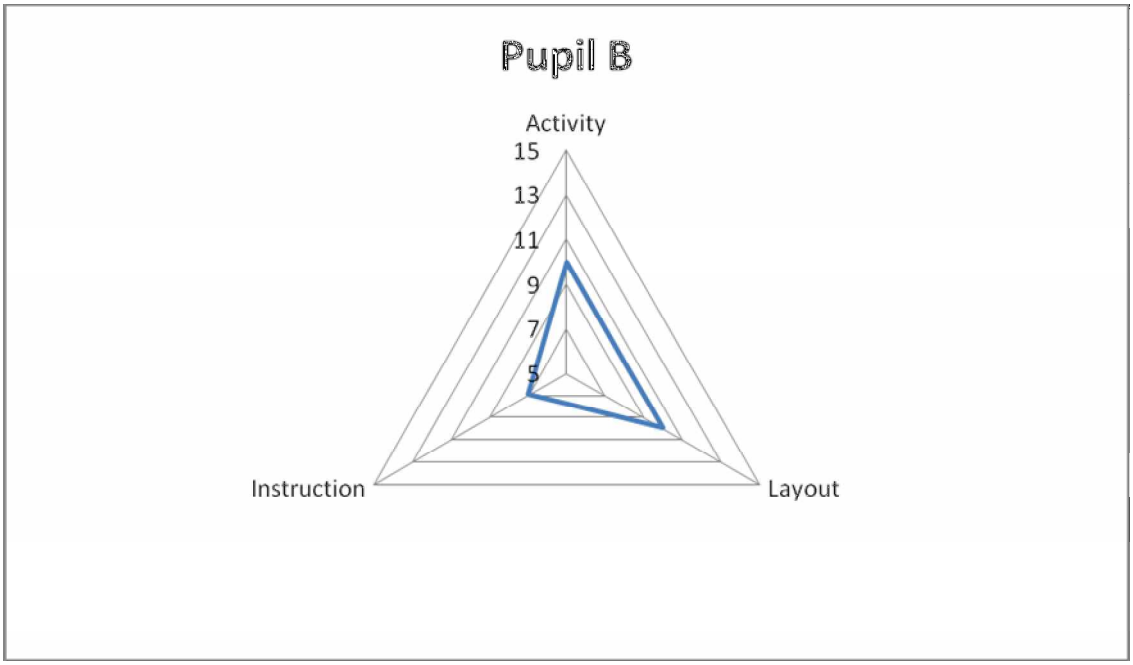
In the layout section the lowest score was 10 and the highest score was 14 giving the layout section an average score of 12.

The activity section had appeared to have the least variance in response. The score ranged from a highest of 13 to a lowest of 10. This gives the activities section an average score of 11.5.

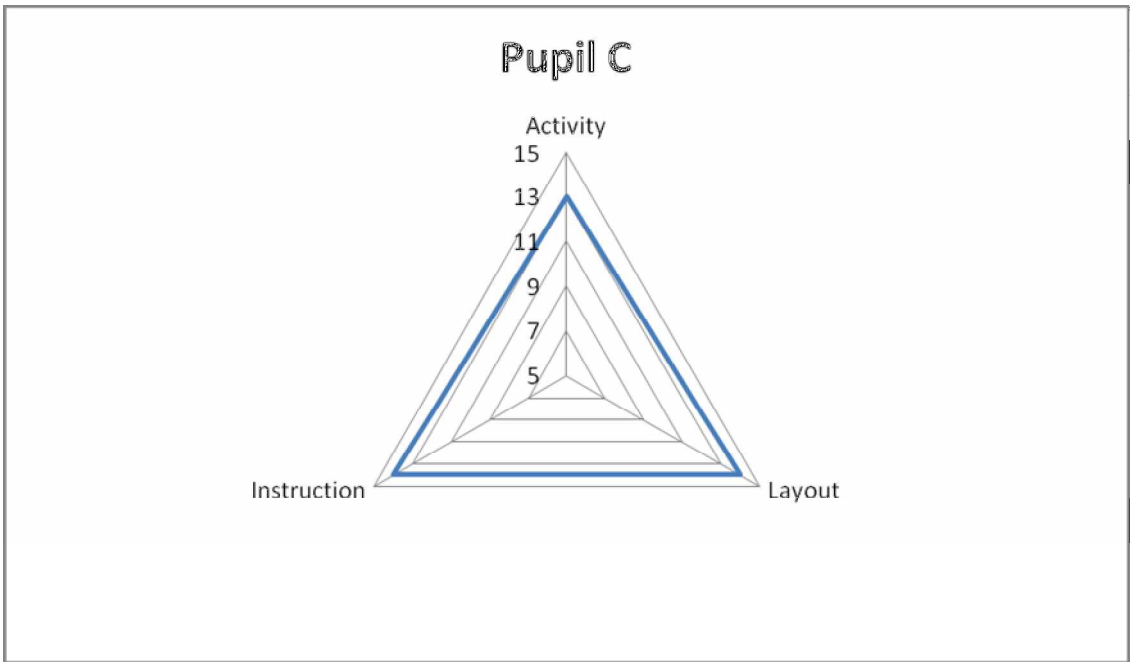
To further expand on these results each user's individual scoring has been presented using a radar graph to show variances between the sections scoring.



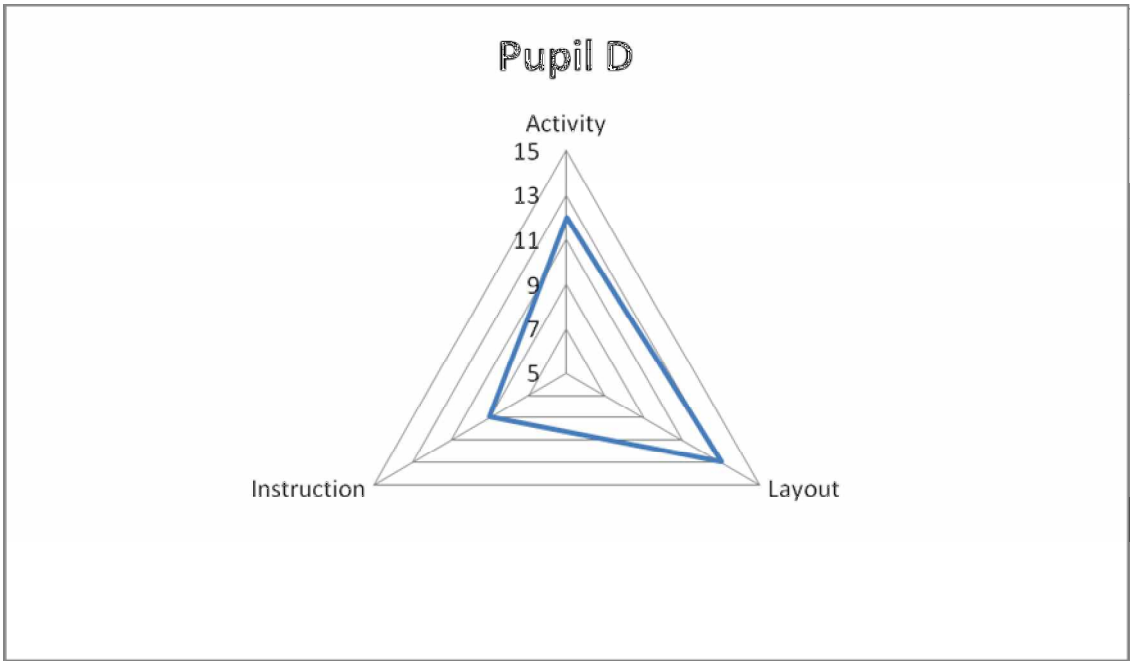
Viewing Pupil A's response shows that the user preferred the layout of the game to either of the other two areas of evaluation. The user gave an equal grading to both activity and instruction.



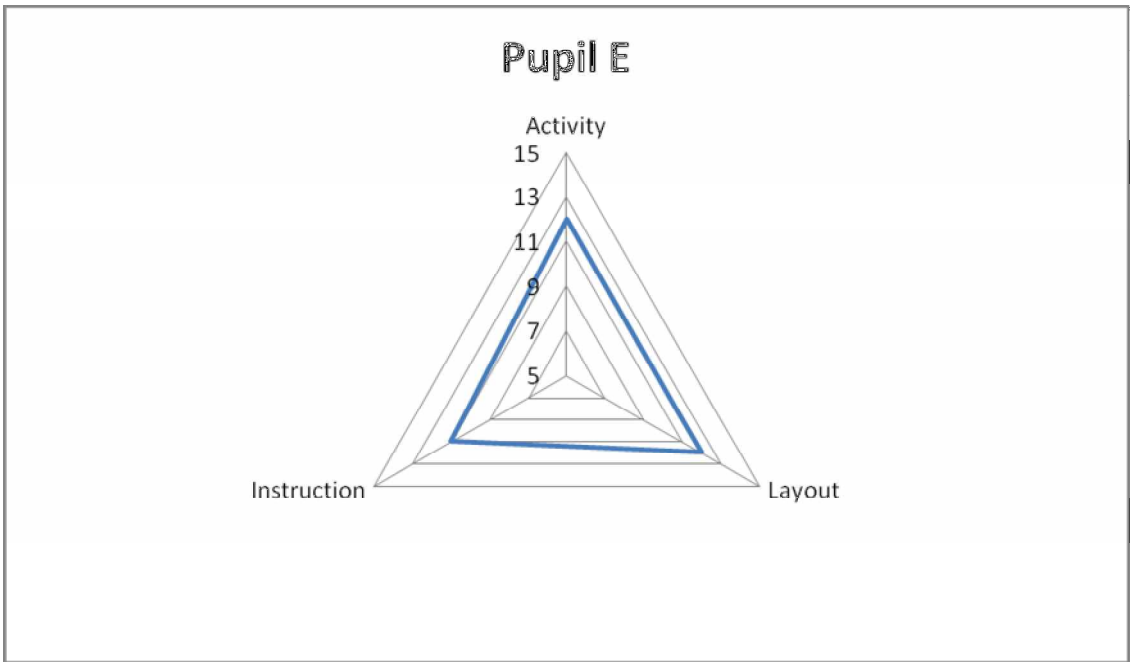
Pupil B gave equal weighting to both the layout and activity sections however gave a far lower mark than anyone else for the instruction section.



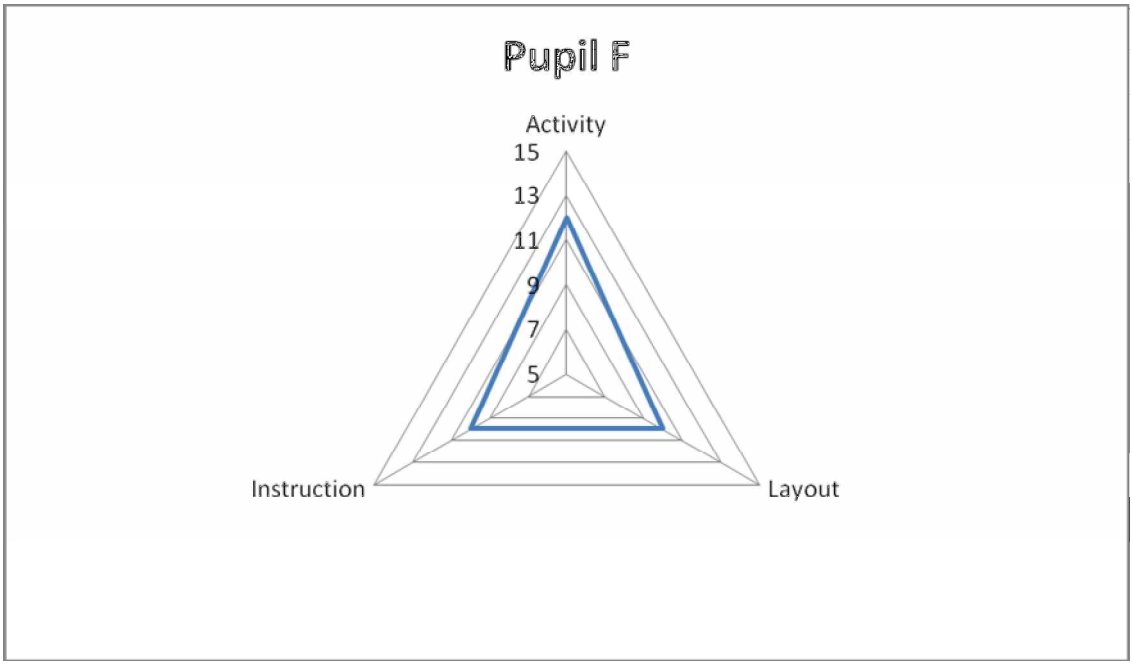
Pupil C gave an equal score to both instruction and layout sections however indicated that the activity section was lacking in what these areas encompassed. This can be seen to resemble Pupil A in favouring layout over activity.



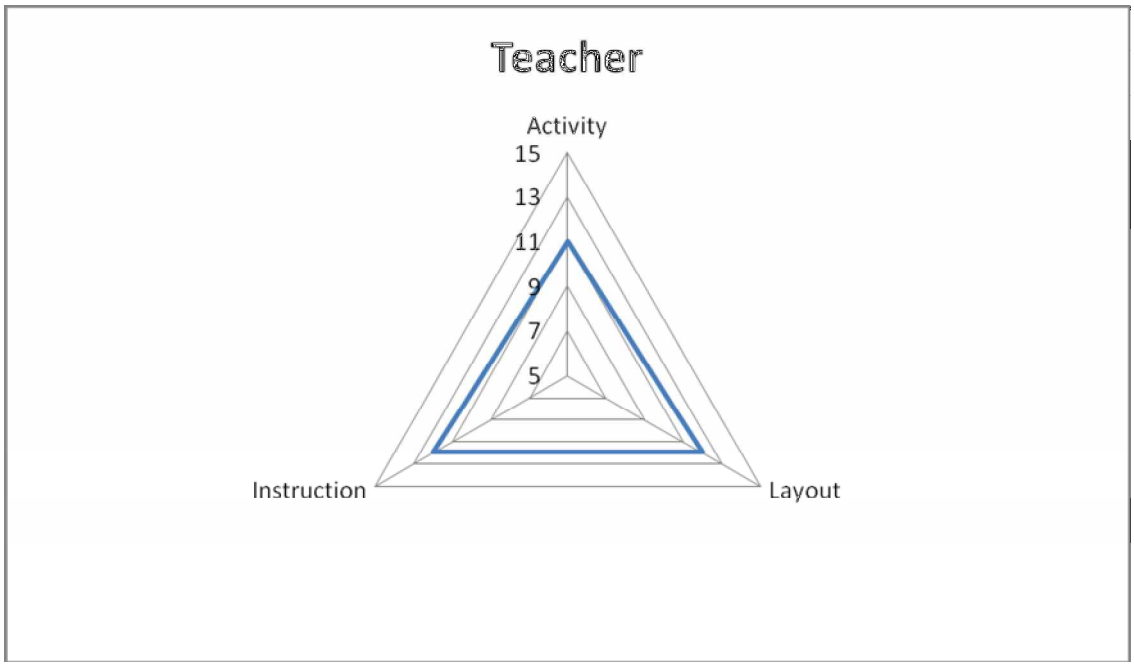
Pupil D seems to mimic pupil B however being somewhat more generous with the scoring. The highest scoring section is layout and the lowest scoring section is instruction. Activity seems to fall between these two sections in this pupils grading.



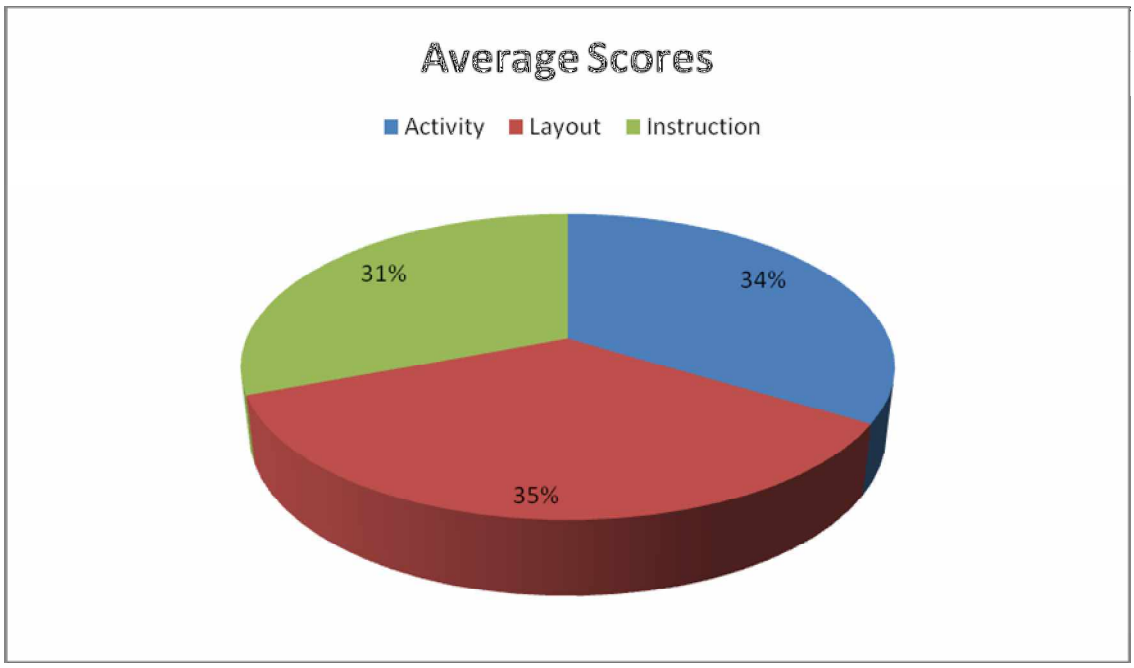
Pupil E follows the trend set by pupils B and D by favouring activity and layout over instruction.



Pupil F is the only user to favour activity over the other two sections. Of the three areas of evaluation the user scored layout the lowest.



Analysing the teachers response shows that this user felt that both layout and instruction were more important than activity.



By analysing the average scores given by all the users for each section it is evident that users seem to value each of the three evaluation sections relatively equally. Overall it can be seen that layout is given the most importance and instruction the least however the variance in these sections is so small that it is clear there must be balance in order for the product to be of value to the user.

5. Conclusions

This section of the report is used to analyse the results gathered from the all users connected to the project. The results of the interviews and user opinion questionnaire are evaluated and the overall conclusions of the undertaking of the project are provided.

5.1 User Based Analysis Conclusions

Analyses of the user based evaluations indicate that generally the children involved enjoyed using Dr. Kawashima's Brain Training. Several of the children found issue with the handwriting recognition employed by the game and found this to be both frustrating and interfered with the enjoyment of the package.

To analyse the results of the interviews conducted it was appropriate to relate the answers directly to the heuristics that underpinned the questions

Question 1 was used to assess the visibility of system status. The user's responses to this question were positive therefore the game could be considered to conform to this heuristic however the phrasing of the question did not fully extrapolate the response that would evaluate this heuristic. In retrospect there could have been subsidiary questions or a better focused question used to extract a more robust answer from the user.

Questions 2 – 4 were used to assess the match between the system and the real world. The responses to these questions indicate that the users did relate objects within the game to real world conventions such as the likeness to workbooks used in class and the use of the touch screen and stylus as data input however again the answers did not fully explain the true understanding of the heuristic and again could be altered in order to gain a fuller understanding.

Question 5 was used to assess the user's opinion on control and freedom within the package. The results indicate that most users were comfortable with the level of control and freedom they had whilst using the package. Most of the users were familiar with the Nintendo DS and therefore already had an understanding of the basic operations of the machine and the conventions used within Dr. Kawashima's Brain Training were familiar to most of the children such as touching buttons on the screen with the stylus to select an object and writing on the screen to input data. It can therefore be concluded that Dr. Kawashima's Brain Training conforms to the usability heuristic of user freedom and control.

Questions 6 – 9 did not conform specifically to a single heuristic although the responses did reveal valuable information from the user's with regards to usability. The results to the questions revealed that the users enjoyed the inclusion of a virtual agent within educational software, the agent in this case being an avatar of Dr. Kawashima. The virtual agent acted as an authority to the user however also spoke their language so they did not have difficulty in relating to it as an authority figure. The children relied upon the instruction from Dr. Kawashima more than they did from their teacher or from the instruction manual that explains the operation of the game. The answers to these questions also revealed that some of the children enjoyed the fact that the game itself fitted the criteria of a lesson more than a traditional video game. The reason given for this indicates that the children would be less inclined to engage with the package if they were being deceived by masking the educational aspects of the game. At the same time it must not be

too similar to the lessons the children already participate in or they are then much less likely to engage in the software at all.

Question 10 was used to assess the flexibility and use of the package. Although the answers to the question did not confirm whether the package conformed to this heuristic, through analysis of the overall responses it became clear that the package did indeed offer the user a degree of flexibility regarding its use. The children were encouraged to be self motivated when it came to making use of the various parts of the game and this flexibility gave the children a feeling of responsibility over their own learning outcomes. Overall the system could be said to conform to the heuristic of flexibility and use.

Question 11 and 12 were both used to assess aesthetic and minimalist design of the software. The responses indicated that the users did feel that the game was aesthetically pleasing and did not overwhelm them or leave them at any stage. None of the users reported any major difficulties with understanding the layout or the instructions and commented on how the design seemed familiar since they had used workbooks in class that were of a similar appearance.

Questions 13 – 16 were used to assess the heuristic relating to diagnosis and recovery of errors. The users did not comment on any system errors that had occurred and must therefore conclude that there were no system errors. Any human errors were related directly to content not operation of the game.

Questions 17 – 19 were used to assess the help and documentation aspects of the game. The general response from the user's to this seemed to indicate that user intuition and in game instructions were adequate to perform the necessary operations.

Questions 20 – 25 were used as open questions to reinforce any findings of the previous questions and to draw out a user based opinion of the software. The results of these questions indicated that the users generally enjoyed using the game as it deviated from the tasks they would normally perform in class.

Overall the main conclusion that was taken from the user group feedback indicated that the children enjoyed the stylus and touch screen control of the system and this was preferable to using a standard keyboard and mouse to manipulate data within the package. The user group indicated that their enjoyment of use of the package was directly related to the fact that the content of the software was delivered via the Nintendo DS which was viewed as a popular games console and one that almost all of the children had used prior to taking part in the experiment.

It is also important to note that the user group indicated that the design of the game was preferable for learning software as it was easily recognizable as learning material. This indicates that children are willing to use educational software so long as the educational content is not hidden or disguised. Most of the children involved in the project referred to the package as a game at all times and although several users indicated that they felt using the package was similar to learning a lesson they comment that the content was enjoyable and more engaging than using standard pen and paper learning techniques. Part of the reason the children enjoyed the game must be directly attributed to the delivery platform since the children had a favourable opinion of the Nintendo DS prior to taking part in the experiment.

5.3 User Opinion Analysis

The results of the user opinion questionnaire based upon Druin's user enjoyment evaluation returned generally favourable opinion for all three sections of evaluation. This is indicated by the fact that the users involved tended to give roughly equal scoring to each section and as a result all sections scored approximately 33% each for importance.

The layout evaluation indicated that users found the effort involved in operating the package easy. The results also indicate that the users generally found the look of the game to be important and rated their satisfaction level between normal and happy. This leads to the conclusion that the layout of the game is important with regards to user engagement and enjoyment. Since the users evaluated were all children the results show that there is a generally favourable opinion to basing the design of educational software on the likes of workbooks as opposed to using ambiguous concepts. The design of the game evidently reflects the way the user will interact with the game and as such by providing a game that looks like a workbook the users will be more encouraged to treat the game as a learning tool. This would also indicate that the educational material the game is attempting to introduce the user to will not be lost.

The activity section of the evaluation indicated that users were happy with using the game, found it easy to play and that they rated using the game as important in their daily tasks. The evaluation took place when the children had been using the game already for a period of 6 weeks and as such the use of the package was not new to them yet the concept of using a video game to learn could still be considered to be relatively novel. This may have interfered with the opinion of these results.

The instruction evaluation scored slightly lower than the other two sections. The general opinion indicated that the users found the instructions to be neither easy nor difficult to follow and found them to be neither helpful nor unhelpful with regards to using the game. The children also indicate that they were between normal an unhappy with the instructions and needed to use a fair amount of intuition to operate the package. This could be attributed to the fact that the children were never the intended user group for the software and as such their needs have been neglected in the design. For the game to be productive for teaching primary school aged children there would appear a greater need to focus the design of the instructions to be more geared towards this user group. The inclusion of the virtual agent in the form of an avatar of Dr. Kawashima did go some way to provide the user with adequate in game instruction and as a point of reference. The agent also presented the user with a degree of personality in an attempt to allow the user to relate to the character however with a limited list of response and provided no way for the user to directly query any of the content.

5.4 Analysis and Opinion provided by Teacher

Analyses of the evaluation provided by the teacher involved in the project show that the package is beneficial to children in the classroom. From a usability perspective the teacher indicated that the game did not provide the children with a level of difficulty that exceeded the children's limitations.

The teacher was asked the same questions as the users in attempting to evaluate this section and again with retrospect perhaps it would have been far more beneficial to construct a more thorough question structure to extract more relevant information. Ultimately the responses given by the teacher answered little towards evaluating the HCI of the software and gave more of an opinion on what the user though of the use of the package in general terms.

5.5 Project conclusions

The organisation of resources and contact with School X throughout the project was successful. The meetings with the teacher and the children involved in the project was all prearranged and discussed to ensure that the project would not interfere with

Overall the results gathered by the project do not answer the research question posed at the start of the report to a sufficient level. One reason for this was the lack of structure that was employed in the data gathering techniques. The questioning, although based upon Nielsen's Usability Heuristics and guideline to evaluate user satisfaction, were not constructed with enough attention to detail and failed by being too vague and unfocussed.

The data catching techniques, whilst proven credible through discussion, were constructed incorrectly for the purposes of the project and did not gather the depth or detail of response necessary to evaluate the HCI of the software to a credible level. This could have been overcome by further research into evaluation methods and especially evaluation of software designed for children. Nielsen's usability heuristics may not have been the correct guideline to base the interview structure on or perhaps the methods employed in the interview structure should have been researched further than they were.

The production of the report lacked a methodical approach and the overall quality of the project suffered as a result.

5.5 Future work

In order to maximize the project future work would include refining the primary research techniques in order to gain insightful results from questioning the users. A better understanding of HCI evaluation would also benefit the project and a better management of time and task delegation would also improve the quality of the report. The biggest shortcoming of the project was a limited degree of background research. In review the weight of importance of the project was realized too late into the timescale and as such the overall project suffered because of this.

References

Adams,D. & Cawardine,M.(1991).*Last Chance To See. 2nd Ed*. London: Pan Ltd.

Amory,A.(2007).Game object model version II: a theoretical framework for educational game development. *Educational Technology Research and Development.* 55 pp51-77.

BBC News: Brain Games Aim to Boost Your IQ.(2006).[Online].Available from: http://news.bbc.co.uk/go/pr/fr/-/1/hi/technology/4930996.stm [Accessed: 11th November 2008].

BBC News: Daily Computer Game Boosts Maths.(2007).[Online].Available from: http://news.bbc.co.uk/go/pr/fr/-/1/hi/education/7064196.stm [Accessed: 11th November 2008].

Bers,M. & Cassell,J.(1997).Storytelling Systems: Constructing the Inner Face of the Interface. *Cognitive Technologies Proceedings '97,* pp98-108.

Bers,M. & Cassell,J.(1999). Interactive Storytelling Systems for Children: Using Technology to Explore Language & Identity. *Journal of Interactive Learning Research,* 9 pp603-609

Brain Training for young and old – arts and entertainment – trends in japan.(2006).[Online].Available from: http://web-japan.org/trends/arts/art060728.html [Accessed: 4th February 2009].

Brain Training the fun way; news: students: BCS.(2006).[Online].Available from: http://www.bcs.org/server.php?show=ConWebDoc.4011 [Accessed: 18th December 2008].

De Freitas,S. & Oliver,M.(2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education,* 46 pp249-264

Dix,A. Finlay,J. Abowd,G. & Beale,R.(2004).*Human-Computer Interaction.3rd Ed*. Essex: Pearson Education Ltd.

Druin,A.(1999). *Cooperative Inquiry. Developing new technologies for children with children. The CHI is the limit.* Addisson-Wesley, Reading, MA.

Druin,A.(2002). The role of children in the design of new technology. *Transactions on Computer Human Interaction,* HCIL Technical Report No 99-23.

Edutainment: Definition from answers.com(2008).[Online].Available from: http://www.answers.com/topic/edutainment [Accessed: 11th November 2008].

GamespotUK.(2009).[Online].Available from: http://uk.gamespot.com accessed [January 14th 2009].

Garris,R. Ahlers,R. & Driskell,J.E.(2002). Games, motivation and learning. Simulation and gaming. *An Interdisciplinary Journal of Theory, Practice and Research* 33 pp43-56

Gibbon,D., *Gaming-News-Nintendo to hand out free DS Consoles-DigitalSpy*.(2008).[Online].Available from:

http://www.digitalspy.co.uk/gaming/a97392/nintendo-to-hand-out-free-ds-consoles.html [Accessed: 11th November 2008].

Go,K., Carroll,J.M. & Imamiya,A.(2004). The Blind Men and The Elephant, views of scenario based system design. *Interactions,* 6 pp45-53

Igarashi,T.,Matsuoka,S. & Tanaka,H.(1999).Teddy: A sketching interface for 3D free form design. *Proceedings of SIGGRAPH '99,* pp409-416.

IGN:GDC2005: Iwata Keynote Transcript.(2005).[Online].Available from: http://uk.cube.ign.com/articles/595/595089p1.html [Accessed: 11th November 2008].

InsideGamer NintendoDS.(2008).[Online].Available from: http://www.insidegamer.nl/nintendods/drkawashimasbraintraininghoeoudisjouwbrein/memberrecensies/2148 [Accessed: 11th November 2008].

Jacobson,I., Christersson,M. Jonsson,P. & Overgaard,G.(1992). *Object-oriented Software Engineering, A Use Case Driven Approach.* Addisson-Wesley, Reading, MA.

Jegers,K., 2007. Pervasive gameflow: Understanding player enjoyment in pervasive gaming *ACM Comput.Entertaint.* 5,1,Article 9(January 2007).

Kawashima,R.(2005).*Dr Kawashima Train Your Brain: 60 Days To a Better Brain*. London: Penguin Books Limited.

Kiili,K.(2005). Digital game-based learning: Towards an experiential gaming model. *The Internet and Higher Education*. 8 pp13-24.

Kim,S., Cho,Y., Park,K.S. & Lim,J.(2007).Development of a Handheld User Interface Framework for Virtual Environments. *Virtual Reality HCII 2007,* LNCS 4563 pp253-261

LostGarden game design review: DS Training for Adults.(2005).[Online].Available from: http://lostgarden.com/2005/10/game-design-review-ds-training-for.html [Accessed: 11th November 2008].

Ma,Y. Williams,D. Prejean,L. & Richard,C.(2007). A Research agenda for developing and implementing educational computer games. *British Journal of Education Technology*. 38 pp513-518.

Michael,D. & Chen,S.(2006).*Serious Games: Games that educate, train and inform.* Thomson Course Technology. Boston, MA.

Newman,W.M.&Lamming,M.G.(1995).*Interactive System Design*. Essex: Pearson Education Ltd.

Nielsen,J.(1990).*Coordinating User Interfaces for Consistency*. San Diego, CA: Academic Press

Nielsen,J.(1994).*Usability Engineering*. San Diego, CA: Morgan Kaufman.

Nielsen,J.(1995).*Advances in Human-Computer Interactions*. Norwood, NJ: Ablex Publishing

Norman,D.A.(1988).*The psychology of everyday things.* New York: Basic Books.

Oh,S. & Woo,W.(2008). ARGarden Augmented Edutainment System with a Learning Companion. *Transactions on Edutainment,* LNCS 5080 pp40-50

Pane,J.F.(1999). Designing a programming system for children with a focus on usability. *Proceedings of CHI '98,* pp62-63.

Potts,C.,Takahashi,K. & Anton,A.I.,(1994).*Inquiry Based Analysis of System Requirements(GIT-CC-94/14).* College of Computing:Georgia Institute of Technology.

Prensky,M.(2006). Digital Natives. *Learning in the Digital Age.* 63 pp8-13

Ren,X. & Moriya,S., 2000. Improving selection performance on pen-based systems: a study of pen-based interaction for selection tasks. *ACM Transactions on Human-Computer Interaction,* 7(3) pp384-416

Squire,K., *Cultural framing of computers/video games-Game studies.*(2002).[Online].Available from: http://www.gamestudies.org/0102/squire/ [Accessed: 9th February 2009].

Sweetser,P. & Wyeth,P.(2005).Gameflow: A method for evaluating player enjoyment in games. *ACM Computers in Entertainment* 3(3).

Tondeur,J. Van Braak,J. & Valke,M., 2007. Towards a typology of computer use in primary education. *Journal of computer assisted learning* 23 pp197-206

Tondeur,J. Valke,M. & van Braak,J., 2008. A multidimensional approach to determinants of computer use in primary education: Teacher and school characteristics. *Journal of computer assisted learning,* 24 pp494-506

Video Game Demographics.(2008).[Online].Available from: http://ezinearticles.com/?video-game-demographics&id352934 [Accessed: 11th November 2008].

Wang,D., Li,J. & Dai,G.(2007). Usability evaluation of children's edutainment software. *Usability & Internationalization,HCII2007* LNCS 4559 pp622-630

Westera,W., Nadolski,R.J., Hummel,H.G.K. & Wopereis,I.G.J.H., 2008. Serious games for higher education: a framework for reducing design complexity. *Journal of computer assisted learning,* 24(5) pp420-506

Appendix A

Pupil A

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "Yes, it was always easy to know when it was my turn."

2. Could you see a purpose in what you were doing?

   "Not other than it let us play games in class."

3. Could you relate it to anything else you have done in class?

   "The questions with the sums and the one with the clock but apart from that not really anything else."

4. Could you relate it to anything you do out of class?

   "Just playing games, although I have followed some of the tips the man gave me and try to add up the shopping in my head at the supermarket now."

5. What did you think about the stylus and touch screen input?

   "I like the way I was able to write directly onto the screen but sometimes the game did not recognise my style of writing. I had to change the way I drew 7s and the way I drew 9s."

6. Did it feel like you were learning a lesson or playing a game?

   "To start with it was more like a game but after a few weeks it started to feel like a lesson, but a good lesson not a boring one."

7. How much attention did you pay to Dr. Kawashima?

   "At the beginning I listened to him and tried to do what he said. I liked the tips he gives to keep your brain active even when not playing the game."

8. Do you think he is a good character for a game?

   "He was ok but not the best."

9. Did you know he was a real person?

   "No, I never thought about it."

10. Do you know any "cheats" to get the results you wanted? (workarounds/loopholes)

    "No, I never tried to find any."

11. Did you like the look of the game?

    "It was okay. It reminded me a lot of things from our class workbooks."

12. Was it ever overwhelming playing the game?

    "I had trouble getting the hang of one or two of the games. The triangle maths was hard to understand and I'm not very good at the time difference game."

13. Did you make any mistakes?

    "Just getting some answers wrong. The game sometimes mistook what I wrote which was annoying. At first I thought I was doing something wrong but then when I saw other people getting the same problems I stopped worrying about it and just changed the way I wrote some numbers and some words. The word recall game was the worst for not understanding my writing."

14. If yes – did you realise you had made a mistake?

    Answer covered by previous response.

15. If yes – did you know what you had done wrong?

    Answer covered by previous response

16. If yes – did the game show you the right way to perform the task?

    "No it just said I was wrong and moved on to the next question."

17. Did you read the instruction book?

    "No."

18. Did you know what to do?

    "The game explained as I went along."

19. Did you need to help anyone else in the class?

    "We all compared results and asked each other about what ones we got wrong. I helped someone understand the triangle maths after I had been shown what to do."

20. Did you enjoy the game?

    "Yes, it was good fun to play and I feel like it helped my maths."

21. What did you like most?

    "The way it showed you a graph of how well you were doing so you could see where you were getting better and where you needed to do more work."

22. What did you like least?

    "The way that I had to change my handwriting or I would get the question wrong."

23. Would you play the game outside of class?

    "Yes, I asked for it for my birthday."

24. If yes or no – Why?

    "I liked playing a game that helped me with school work."

25. What could make the game better?

    "If there were more mini games in it but I heard there is a second game in the series so maybe that will have more games."

Appendix B

Pupil B

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "It was quite easy to know when the game needed me to do something."

2. Could you see a purpose in what you were doing?

   "Yes, it helped with my maths especially my times tables."

3. Could you relate it to anything else you have done in class?

   "Just the maths but I had never seen the triangle maths before, it was a bit more difficult at first but I got it in the end."

4. Could you relate it to anything you do out of class?

   "Only playing games on the DS."

5. What did you think about the stylus and touch screen input?

   "I liked it. I am left handed and the game let me play it left handed."

6. Did it feel like you were learning a lesson or playing a game?

   "It felt like a lesson but it was better because we were in charge of what we did. I liked being able to chose to do one thing one day and then something else the other day. It kept me interested in it by not being the same every day."

7. How much attention did you pay to Dr. Kawashima?

   "Not very much. He repeated himself an awful lot but he helped when you unlocked a new game and did not understand how to play it."

8. Do you think he is a good character for a game?

   "He was quite boring."

9. Did you know he was a real person?

   "Only because I heard you talking about it with someone else."

10. Do you know any "cheats" to get the results you wanted? (workarounds/loopholes)

    "If you got the answer right then the number would appear quicker."

    Pupil was asked to further explain this answer.

    "Well if you got asked 2x2 and you wrote 4, the 4 would appear in the answer section faster than if you wrote 5."

11. Did you like the look of the game?

    "It was quite good. There wasn't much colour but I liked that it was simple and a bit like the workbooks we have used before."

12. Was it ever overwhelming playing the game?

    "Not really. It took a little bit of getting used to at first but I got the hang of it quite quickly."

13. Did you make any mistakes?

    "Just getting answers wrong sometimes but some of them were the game not understanding my writing."

14. If yes – did you realise you had made a mistake?

    "Usually yes but it was more when the game didn't understand what I wrote."

15. If yes – did you know what you had done wrong?

    N/A

16. If yes – did the game show you the right way to perform the task?

    "No, if you get an answer wrong then it just moves on to the next question."

17. Did you read the instruction book?

    "No."

18. Did you know what to do?

    "Pretty much. It was quite simple to understand what you had to do. All you had to remember was how to play each of the games."

19. Did you need to help anyone else in the class?

    "Yes, we helped each other and all talked about what we had done after we were finished."

20. Did you enjoy the game?

    "Yes, it was good and different from normal lessons but it did start getting a bit boring after a while."

21. What did you like most?

    "I liked being in control of what I did and what I didn't do each day. I also liked being able to play it left handed."

22. What did you like least?

    "It started to get very repetitive when I had unlocked all the games and once I had my brain age at 24 it didn't get any better."

23. Would you play the game outside of class?

    "Probably not."

24. If yes or no – Why?

    "It just got a bit boring and it would feel a bit like doing homework playing it outside of class."

25. What could make the game better?

    "Perhaps a story mode a bit more like Professor Layton it might be more interesting."

Appendix C

Pupil C

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "It was quite easy yes."

2. Could you see a purpose in what you were doing?

   "Not really it was just good fun playing computer games in class."

3. Could you relate it to anything else you have done in class?

   "Some of the maths but apart from that not really."

4. Could you relate it to anything you do out of class?

   "Playing games."

5. What did you think about the stylus and touch screen input?

   "It was good. It meant that I didn't have to remember different buttons and that you could put the answer in quicker than picking it from a list like other maths games."

6. Did it feel like you were learning a lesson or playing a game?

   "To begin with it was like a game but after a while started to feel more like a lesson."

7. How much attention did you pay to Dr. Kawashima?

   "Quite a lot. His hints were good for playing the game."

8. Do you think he is a good character for a game?

   "He was quite good and he was quite funny sometimes. He said happy birthday to me on my birthday which was good."

9. Did you know he was a real person?

   "Yes, it said so in the instruction book."

10. Do you know any “cheats” to get the results you wanted? (workarounds/loopholes)

    “No”

11. Did you like the look of the game?

    “It was quite plain but it was easy to understand that way.”

12. Was it ever overwhelming playing the game?

    “No, you didn’t get to play all the games at the beginning and they were only unlocked as you kept playing. When you get the hang of one game a new one was unlocked which was better than getting them all at once.”

13. Did you make any mistakes?

    “Getting answers wrong yes.”

14. If yes – did you realise you had made a mistake?

    “Yes but sometimes I don’t think it was my fault. Sometimes I think it was the game not understanding the way I write.”

15. If yes – did you know what you had done wrong?

    “Sometimes yes but not always.”

16. If yes – did the game show you the right way to perform the task?

    “No, there was no way to check what you had done wrong without asking someone else how to do it properly.”

17. Did you read the instruction book?

    “Yes, I always read the booklets with games and I borrowed my mum’s copy of the game to practice at home.”

18. Did you know what to do?

    “Not at first but it didn’t take long before I knew what to do.”

19. Did you need to help anyone else in the class?

    “Yes we all helped each other out with what to do.”

20. Did you enjoy the game?

    "It was good fun most of the time but it was annoying when I couldn't get a better brain age."

21. What did you like most?

    "I liked the way that it would ask you what you had for your breakfast or something like that and then ask you again a few days letter and you had to remember what you wrote."

22. What did you like least?

    "I didn't like the game where you had to remember the list of words because I wasn't very good at it."

23. Would you play the game outside of class?

    "Yes, I have already."

24. If yes or no – Why?

    "I wanted to practice and get a better brain age."

25. What could make the game better?

    "If it told you what you had done wrong when you got an answer wrong or perhaps if it told you more what you were very good at and what you were bad at without having to check all the graphs."

Appendix D

Pupil D

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "Usually it was quite easy to follow because it would count down before the game you were to play started."

2. Could you see a purpose in what you were doing?

   "Yes it was to answer questions quickly so you get a good brain age score."

3. Could you relate it to anything else you have done in class?

   "Some of it. The maths were quite easy but it was difficult to do them as fast as the game wanted you to."

4. Could you relate it to anything you do out of class?

   "Not really but I don't think that was a bad thing. If it was too much like things outside of school then you might not take it so seriously."

5. What did you think about the stylus and touch screen input?

   "It was good. I liked the way that you could write straight onto the screen."

6. Did it feel like you were learning a lesson or playing a game?

   "Most of the time it was like learning but not boring things. It felt like a game because you play it on the DS and you are trying to get a better score every day."

7. How much attention did you pay to Dr. Kawashima?

   "To start with quite a lot yes but he said the same thing quite a lot so the more I played it the less I paid attention to him."

8. Do you think he is a good character for a game?

   "He is ok. He is just a floating head though."

9. Did you know he was a real person?

   "I didn't really think about it."

10. Do you know any "cheats" to get the results you wanted? (workarounds/loopholes)

    "No."

11. Did you like the look of the game?

    "Yes it was quite good. It didn't look like any other game I have played since the graphics were very plain. It was more like a book than a game but a book that told you what you were doing. It was a bit like Harry Potter."

12. Was it ever overwhelming playing the game?

    "Not really. I just had trouble with the game where you had to remember a list of words and write them down."

13. Did you make any mistakes?

    "Sometimes yes."

14. If yes – did you realise you had made a mistake?

    "Most of the time."

15. If yes – did you know what you had done wrong?
    "Most of the time."

16. If yes – did the game show you the right way to perform the task?

    "No, it just told you that you got something wrong then moved on."

17. Did you read the instruction book?

    "No."

18. Did you know what to do?

    "Not really to begin with but it did not take long to get used to how to play the game."

19. Did you need to help anyone else in the class?

    "I asked for help a few times but not very much."

20. Did you enjoy the game?

    “Yes it was quite good.”

21. What did you like most?

    “I liked being able to play computer games in class.”

22. What did you like least?

    “Not being able to get a better score in the daily training.”

23. Would you play the game outside of class?

    “Maybe if someone gave it to me but I probably wouldn’t pick it.”

24. If yes or no – Why?

    “It just seemed to get a little bit boring after a while.”

25. What could make the game better?

    “If there was more things to do in it.”

Appendix E

Pupil E

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "Yes."

2. Could you see a purpose in what you were doing?

   "At first no but when I played it again after not playing it for a while it makes more sense now."

3. Could you relate it to anything else you have done in class?

   "Again not until after I stopped using the game."

4. Could you relate it to anything you do out of class?

   "Yes, some of the tips in game have come in useful in trying to remember things and doing maths in my head instead of on paper."

5. What did you think about the stylus and touch screen input?

   "I like the way you can write straight onto the screen instead of using buttons."

6. Did it feel like you were learning a lesson or playing a game?

   "A bit of both. It never felt like I was playing a game like Professor Layton but it didn't feel like doing lessons in class either."

7. How much attention did you pay to Dr. Kawashima?

   "A lot to begin with but eventually I figured out what to do without his help."

8. Do you think he is a good character for a game?

   "He's a bit more real than Professor Layton who is more like a cartoon. He looks and talks more like a real person too."

9. Did you know he was a real person?

   "Yes I had read that."

10. Do you know any “cheats” to get the results you wanted? (workarounds/loopholes)

    “No, but I didn’t always do all the daily tasks and would just do enough to get my stamp and the easy ones then take the test. You don’t have to do all the games.”

11. Did you like the look of the game?

    “It was ok but it was a bit boring after a while.”

12. Was it ever overwhelming playing the game?

    “Not really it was very easy to use once you played it a couple of times.”

13. Did you make any mistakes?

    “Sometimes but the biggest problem was with the game not recognising my voice in the colours test or my handwriting in some parts.”

14. If yes – did you realise you had made a mistake?

    “Not always.”

15. If yes – did you know what you had done wrong?

    “Not always.”

16. If yes – did the game show you the right way to perform the task?

    “No it just moves on to the next question but it doesn’t help you by telling you what to do.”

17. Did you read the instruction book?

    “A little bit but not in depth.”

18. Did you know what to do?

    “I picked it up quite quickly.”

19. Did you need to help anyone else in the class?

    “Yes, we started off asking the teacher a lot but then we started asking each other what to do.”

20. Did you enjoy the game?

    "It was ok. By not playing it for a while it was a surprise how bad I did when I played it again."

21. What did you like most?

    "It was different to what we were doing in class at the time and we got to play games in class and talk about it afterwards."

22. What did you like least?

    "Some of the games were quite difficult at first and it was annoying when your brain age went up instead of down."

23. Would you play the game outside of class?

    "I did at first but not anymore."

24. If yes or no – Why?

    "I wanted to get my brain age to 20. I managed it a couple of times and after that I just didn't bother playing it anymore because there were better games to play."

25. What could make the game better?

    "If there were more things to do. It would be good if there was different games that were like the Mario party games or even the big brain academy for the wii."

Appendix F

Pupil F

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "Yes it was pretty obvious when you were to play and when you were to listen."

2. Could you see a purpose in what you were doing?

   "Sometimes yes. The math was a lot simpler than we had done in class but the game wanted you to do them really quickly and I wasn't used to that."

3. Could you relate it to anything else you have done in class?

   "Just the maths and some of the games we had talked about like telling the time."

4. Could you relate it to anything you do out of class?

   "Not before but after we had finished using the game it made more sense when you were trying to remember things."

5. What did you think about the stylus and touch screen input?

   "It was good. I like playing the DS because you don't really need to remember a lot of buttons. I don't know the game could be played without the DS because it was important to answer the questions quickly."

6. Did it feel like you were learning a lesson or playing a game?

   "Mostly playing a game because it was on a games machine. The things in the game were not really what you have to do in most games but it always felt more like a game than a lesson."

7. How much attention did you pay to Dr. Kawashima?

   "Not a lot, after a while he started to repeat himself a lot."

8. Do you think he is a good character for a game?

   "He was quite good yes."

9. Did you know he was a real person?

   "Yes someone told me."

10. Do you know any “cheats” to get the results you wanted? (workarounds/loopholes)

    “No.”

11. Did you like the look of the game?

    “Yes. I liked being able to see all the graphs of how well I had done in the past”

12. Was it ever overwhelming playing the game?

    “Not really. Some games were a little tricky but generally finding your way about in the game was quite easy.”

13. Did you make any mistakes?

    “Not very often.”

14. If yes – did you realise you had made a mistake?

    N/A

15. If yes – did you know what you had done wrong?

    N/A

16. If yes – did the game show you the right way to perform the task?

    N/A

17. Did you read the instruction book?

    “No, I tend to just pick it up as I play with most games.”

18. Did you know what to do?

    “After a few times playing it yes.”

19. Did you need to help anyone else in the class?

    “Yes, we would ask each other if we got stuck and the one who did best would get to talk about what they did to their group.”

20. Did you enjoy the game?

    "Yes it was good fun and it was good to play games in class but some of the games were quite difficult to do well in."

21. What did you like most?

    "I liked it when you got different things to do before you started the main game like drawing pictures from memory. These were good because you didn't decide when they happened and not everyone got the same ones at the same time."

22. What did you like least?

    "After a few weeks it started to get a bit boring."

23. Would you play the game outside of class?

    "I would but I don't think it would be one of my favourites. I would like to get a better score but apart from that I don't think so."

24. If yes or no – Why?

    "I would like to get a better score and it was quite fun playing it again after not playing it for a while."

25. What could make the game better?

    "If it showed you what you did wrong when you didn't do well in one of the games maybe I would have got better at them faster then."

Appendix G

Teacher

1. Was it easy to know when the game required you to interact with it and when it wanted you to follow instruction?

   "Yes, it was all laid out very efficiently and was good at telling you when you were supposed to be paying attention and when you were supposed to be doing something. There was never any complaint either when it came to children not knowing when they were to be writing or not"

2. Could you see a purpose in what you were doing?

   "Really, at first I was quite wary that introducing the game to the class would lead to unruliness and the material covered seemed a little bit too simple but when I played the game myself I realised how difficult it could be to get a good brain age and realised that there could be benefits to the challenge involved."

3. Could you relate it to anything else you have done in class?

   "The math was a little bit simpler than most of the children were used to but it became apparent that to score high you had to answer the questions really quickly which we had not done in class before. It was certainly an interesting way of teaching and I would be very interested to discover what affect the speed the calculations take place at actually matters in learning the material. Some of the little hints and tips that Dr. Kawashima gives out throughout the course of the game have come into play and we have devised a few class games based around the material he mentions"

4. Could you relate it to anything you do out of class?

   "Apart from playing games on their computers I couldn't see much that the children would use from the game outside class although I do know that a few of them have actually got the game at home and use it at the weekends when they are not in class so they can keep up with the work."

5. What did you think about the stylus and touch screen input?

   "I quite liked it. It made a change from using the internet based learning games the kids were used to. It gave a bit more freedom and they all liked that they had their own signature as their profile."

6. Did it feel like you were learning a lesson or playing a game?

   "When I used it, it felt like a game. There were aspects of it that made it seem like a lesson but most of the time I thought I was playing a game"

7. How much attention did you pay to Dr. Kawashima?

   "Quite a lot. The tips he gave on things to train your memory were very useful and the way he was a bit silly certainly helped the children warm to him as a teacher. He explained everything in a very simple way and added a touch of humour to a lot of it to keep the topics light and refreshing."

8. Do you think he is a good character for a game?

   "I don't think he will take over from Mario or Lara Croft any time soon but it is certainly interesting using a real doctor as a character in a video game. Especially when he is trying to help you improve your health but in a fun way using a concept the children are familiar with."

9. Did you know he was a real person?

   "Yes, it was indicated in the learning material that was issued with the game."

10. Do you know any "cheats" to get the results you wanted? (workarounds/loopholes)

    N/A

11. Did you like the look of the game?

    "It was quite simple but I think that kept it easy for the children to follow. Also it didn't look too much like a game which stopped their minds wandering and kept them focused on the tasks they were given."

12. Was it ever overwhelming playing the game?

    "I wouldn't say overwhelming. There was a good pace of work and there were easy mechanisms for viewing your game scores as you went along. The only thing that I was surprised about was the speed at which it expected you to answer at to get a good score. It was a little worrying when you consider that the children are being taught to think about things thoroughly when before they answer but then I suppose that's the point of the game."

13. Did you make any mistakes?

    "Only when it came to the game where you had to remember the list of words. It didn't pick up on my handwriting and this became very frustrating after a few play-throughs. I think that's what kept my brain age so high! To navigate the game was very easy and I don't see how you could "crash" the game since it always seemed to work very efficiently."

14. If yes – did you realise you had made a mistake?

    "Like I already said it wasn't necessarily my mistake, the game just didn't recognise what I was writing all the time and this led to a lot of wasted time trying to get the answer from my head into the system."

15. If yes – did you know what you had done wrong?

    N/A

16. If yes – did the game show you the right way to perform the task?

    "No, there was no guidance on how the game recognised handwriting and there was no explanation given if you got a question wrong it simply gave you a correct or an incorrect response."

17. Did you read the instruction book?

    "Yes. I read the book before allowing the children to use the system even though I had been shown what to do it seemed sensible to me to understand the system as thoroughly as I possibly could before getting the most from its use. I offered the book to the children to read as well, some did some did not. I didn't notice a terrible barrier between those that had and those that hadn't read the instructions. They were more interested in learning it for themselves by playing it."

18. Did you know what to do?

    "Yes I was fully briefed on what to do with the game and what was expected from the children. This was used at the basis for my lesson plans and the game was incorporated into several learning outcomes such as maths tests."

19. Did you need to help anyone else in the class?

    "Some of the children at first were a little confused but not greatly. After they realised it was okay they started asking each other for help instead of me which was great as it gave me time to observe rather than instruct. This let me see exactly how they thought and what they were doing. They treated the exercise as a bit of a deviance from the norm and saw it really as a bit of a skive by playing games in class."

20. Did you enjoy the game?

    "Overall yes, it became very addictive and I found myself wanting to play it over and improve my score."

21. What did you like most?

    "I liked overall concept of a video game that helps you learn and is good for you to play. Anything that gets kids attention is good in the classroom and when they heard that they were going to get to play with Nintendo DS's in class they were all very excited."

22. What did you like least?

    "The material was very limited. After a while you could tell most of the children were losing interest in the content and were more interested in beating their friend's scores. The fact that there are a limited number of games in the package means that I think the lifespan will be quite short."

23. Would you play the game outside of class?

    "Probably but I would not take much notice of the brain age. It's really just a measurement tool not an actual representation so I would take the results with a pinch of salt. "

24. If yes or no – Why?

    "Because it is quite addictive and it does genuinely motivate you. You constantly want to get a better score and you get a real sense of satisfaction when you start to improve on a section that troubled you. I can also see the positive effect of regular use of the game, it motivates you to do better every time you play it."

25. What could make the game better?

> "If possible it would be good if the game could include updatable material and focus on different areas of the curriculum. This was very much rooted in maths and logic and although important it would be good to see different types of material dealt with in this interactive style. I know a lot of the kids have been playing "Professor Layton" because they talk about it and that seems to capture their imagination a bit more than the brain training did although it's just new as well so the novelty might wear off in time."

Appendix H

Pupil A – Overall score = 35/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 11/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult 3 – Normal 4 – Easy ***5 – Very Easy***

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 13/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful 3 – Normal ***4 – Helpful*** 5 – Very Helpful

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 11/15

Appendix I

Pupil B – Overall score = 27/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy ***3 – Normal*** 4 – Happy 5 – Very Happy

Score = 10/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy ***3 – Normal*** 4 – Happy 5 – Very Happy

Score = 10/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful ***2 – Unhelpful*** 3 – Normal 4 – Helpful 5 – Very Helpful

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy ***2 – Unhappy*** 3 – Normal 4 – Happy 5 – Very Happy

Score = 7/15

Appendix J

Pupil C – Overall score = 41/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal 4 – Important ***5 – Very Important***

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 13/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal 4 – Important ***5 – Very Important***

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal 4 – Happy ***5 – Very Happy***

Score = 14/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful 3 – Normal 4 – Helpful ***5 – Very Helpful***

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy 3 – Normal 4 – Happy ***5 – Very Happy***

Score = 14/15

Appendix K

Pupil D – Overall score = 34/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 12/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal 4 – Important ***5 – Very Important***

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 13/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful ***3 – Normal*** 4 – Helpful 5 – Very Helpful

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy ***3 – Normal*** 4 – Happy 5 – Very Happy

Score = 9/15

Appendix L

Pupil E – Overall score = 35/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 12/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 12/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful 3 – Normal ***4 – Helpful*** 5 – Very Helpful

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 11/15

Appendix M

Pupil F – overall score = 32/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 12/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy ***3 – Normal*** 4 – Happy 5 – Very Happy

Score = 10/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful ***3 – Normal*** 4 – Helpful 5 – Very Helpful

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 10/15

Appendix N

Teacher – Overall score = 35/45

- Activity

Effort – "How easy was the game to play?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How important did you rate the game in your daily tasks?"

1 – Pointless 2 – Not Important 3 – Normal ***4 – Important*** 5 – Very Important

Satisfaction – "How happy were you with the game?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 11/15

- Layout

Effort – "How easy was it to see where everything was in the game?"

1 – Very Difficult 2 – Difficult 3 – Normal ***4 – Easy*** 5 – Very Easy

Usefulness – "How important would you say the look of the game was?"

1 – Pointless 2 – Not Important 3 – Normal 4 – Important ***5 – Very Important***

Satisfaction – "How happy were you with the look of the game?"

1 – Very Unhappy 2 – Unhappy ***3 – Normal*** 4 – Happy 5 – Very Happy

Score = 12/15

- Instruction

Effort – "How easy were the instructions to follow?"

1 – Very Difficult 2 – Difficult ***3 – Normal*** 4 – Easy 5 – Very Easy

Usefulness – "How helpful did you find the instructions?"

1 – Very Unhelpful 2 – Unhelpful 3 – Normal 4 – Helpful ***5 – Very Helpful***

Satisfaction – "How happy were you with the instructions?"

1 – Very Unhappy 2 – Unhappy 3 – Normal ***4 – Happy*** 5 – Very Happy

Score = 12/15