The Effectiveness of Computer Based Interactive Oral Health Education.

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Declaration

This thesis represents the original work of the author.

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Synopsis

The Western Isles of Scotland have historically high levels of dental disease in the five year old age group amongst the worst in the UK. The "Action Plan for Scotland" has implemented a multidisciplinary approach to deal with this problem. This includes a major role for schools in supporting and improving oral health, by reducing the availability of cariogenic produce in schools and actively promoting healthier diets.

In light of this the researcher created an interactive computer programme, designed to educate children about healthy eating and improve their ability to identify cariogenic foods. The interactive computer programme was designed to integrate into the school curriculum providing a combined teaching tool and learning resource; for elements of both the health curriculum and IT attainment targets.

To assess the efficacy of the interactive computer programme a blind randomised controlled trial was designed to measure:

- Its ability to teach children the difference between healthy and unhealthy food.

- If it could positively influence the children's selection of playtime snack.

The computer programme was initially assessed by a peer group consisting of Primary School Teachers, Dental staff (Glasgow University Dental School) and Dieticians (Western Isles Health Board). This was to ensure the content contained the correct nutritional and oral health message and that the interactive computer programme was educationally appropriate, for the age group within the study.

The computer programme was then assessed by a user group, consisting of pupils from Sandwick Hill Primary School, aged from four and a half to seven. Changes were then made in relation to the format and content of the programme to improve and refine it.

An initial pilot study was undertaken within Sandwick Hill Primary School to assess the methodology of the controlled trial and the randomisation and blinding of the participants. This also allowed refinement of the assessment tool to be used within the study. The assessment tool was designed to determine the children's ability to identify healthy and unhealthy foods and to record their playtime snack.

Two schools were involved in the controlled trial, Stornoway Primary School and Laxdale Primary School. Positive consent was received for Eighty-six pupils in total. There were forty five boys (52.3%) and forty one girls (47.7%). The mean age was 5.7, (range 4 to 7 years). The teaching staff involved within the study were given a tutorial to explain the use of the programme and the protocols relating to randomisation and blinding. The participants were then randomly allocated to one of two groups, the intervention or control group. Both groups were then assessed to provide a comparative baseline. The intervention group were provided with the interactive computer programme. They were to use the programme for fifteen minutes a time over three weeks. The teachers were encouraged to allow the children to access the programme at least five to six times during this period. The control group were provided with traditional paper based educational material which was completed during class time. After three weeks the children were reassessed and the educational materials removed. The children were then assessed again after three months to assess longevity and retention of the acquired knowledge. The researcher remained blind to group allocation until the key was broken after analysis of the results.

Regarding identification of healthy food, regression analysis showed significant improvement in both groups, but t-tests revealed no significant difference between them. The groups matched well at baseline [Two- Sample T-test for means, p=0.979 95% CI -4.88, 4.76]; the intervention group showed greater improvement at 3 weeks but this was not significant [Two- Sample T-test for means, p= 0.135 95% CI -7.56, 1.04]. There was no difference seen at 3 months [Two- Sample T-test for means. P= 0.547, 95% CI -5.12, 2.74]. There was neither an improvement nor a difference between the two groups in snack selection.

This study provides evidence as to the effectiveness of interactive technology in relation to oral health education. It shows that interactive computer technology can provide an alternative to paper based educational materials. This study does not however show it to be significantly more effective. The study also shows that the use of the interactive computer programme was ineffective in modifying behaviour, in relation to diet, in this age group.

Chapter 1

Literature Review

[1.1] Scotland's dental health

Within Europe, Scotland's dental health is ranked as one of the worst and the Western Isles specifically, is an area of serious concern (NDIP 2003). There have been many reasons suggested for the poor oral health of the Islands, the challenging economic circumstances, low socioeconomic status of the area (Pitts et al 2006, Carstairs 1995) and the difficulty in accessing dental health services (Nuttal et al 2006, Bentley et al 1983). This has all combined to produce a challenging and complex oral health problem, the multi-factorial nature of which means that the solution can never be a simple one.

In an attempt to address these problems the Scottish government has put into place, "The Oral Health Strategy for Scotland." The aim is to transform the oral health of children, who are most at risk, through early intervention with support and education (Forgie 2005, Bentley et al 1983). The dental health improvement programme encourages the development of a multidisciplinary approach to the improvement of child dental health, with the inclusion of parents and extended families, health visitors, teachers, care workers and other professionals.

At the core of the dental health strategy is the education of the individual to improve oral health. Kay and Locker, (1998) found that the early adoption of healthier attitudes created better long-term health benefits. In view of this the author has developed an interactive computer package for use in schools with children aged four to six years. The programme is designed to improve the children's understanding of oral health and diet and, most importantly, recognition of cariogenic foods.

[1.1.1] Caries in relation to diet

The importance of well maintained oral hygiene and reduction of dietary intake of extrinsic non-milk sugars are accepted preventive factors (Pitts et al 2006, Chapman et al 2006, Gibson and Williams 1999). Work by Loveren and Duggal, (2004) questioned fifty four European experts from twenty different countries on the role of diet in caries prevention. All fifty four of the experts and all of the national guidelines mentioned "reduction of the frequency of cariogenic intakes" as the principle dietary measure for caries prevention. It was acknowledged within the study that, it would be unrealistic to assume people would reduce their frequency of snacking to zero, but reducing the cariogenicity of these snacks is crucial in terms of caries prevention. It was also considered more appropriate to promote a generally healthy balanced diet and moderate snacking frequency with healthier options. Well maintained oral hygiene and the use of fluoride toothpastes were also mentioned as equally important features of caries prevention and the inclusion of these features within the computer programme was important.

[1.2] Sample population

The key focus group for this thesis is children in Primary one and two (age range four to six years). This age group was selected for several reasons.

[1.2.1] Caries rates

In the Western Isles the rate of caries within five year olds over the last twenty five years has been very high and amongst the worst in Scotland. This is concerning as the latest UK reports (Pitts et al 2006, Nuttal et al 2006) have shown a stagnant level of caries within this age group and an apparent failure to resolve the issues of early childhood caries. Moreover,

a reduction in treatment of this caries is leading to a pool of untreated decay within this population.

[1.2.2]Low dental registration

Within the Western Isles, there are very low levels of dental registration only 29% of five years olds were registered with a GDP (general dental practitioner) in 2003. The remaining children were dependant on the community service to provide their treatment and care. This high risk group are traditionally poor attendees and more likely to develop chronic disease as a result of inequalities in access and care (Gussy et al 2006, Health Scotland 2007).

[1.2.3] Key psychological stage of development

At this stage of development children in Primary one and two have acquired interactive skills and a degree of self awareness (Piaget 1955). As such, it is appropriate to introduce the ideas about healthy eating and caring for themselves. This age is also characterised by an important transitional period during which the children should be encouraged to learn and stretch their abilities (Boeree 2006).

[1.2.4] Pester power

The child has a role in the family unit. As such, children are becoming increasingly involved in the decision making processes that occur within the average household, this often includes what the child eats. It has been shown that by the age of seven years children have developed significant bargaining and negotiating skills (Harbaugh et al 2007, Robinson 2000). This was seen to be evident in an investigation of lunch box contents by Dental Health Educators in Manchester (Roberts et al 2003) who found that children aged four to seven years had nutritionally better lunches than those of older children aged seven

to eleven years. The latter contained a much higher frequency of crisps, chocolate and fizzy drinks. This was also reflected in comparative studies to assess the nutritional value of children's lunchboxes, the results showed the contents had increased saturated fat levels, salt and sugar levels (Rogers et al 2007, Griffin and Barker 2008, Ruxton and Kirk 1996). As a child's ability to exert pressure and influence over their parents increases, parental control of the diet is undermined leading to a deterioration of the diet (Roberts et al 2003). It is important therefore to educate younger children before they begin to influence the parents' decisions.

[1.2.5] Why education is important so young

A child can be influenced in many ways regarding choice of food so it is important that they recognise and are educated, at an early age, which foods are best for their overall well being. This is important as children are often targeted by saturation advertising for unhealthy foods and snacks. Recently efforts have been made in America to reduce peak time advertising of "junk food" to help combat obesity (Hills 2008, Brown 2006), but with seven to twelve year old children having an estimated disposable income of £11.3 million pounds annually it is a fiercely competitive commercial market. The advertising budget for Coca-Cola alone is $1.9 billion annually, in a soft drinks market worth $243.8 billion annually and Nestle spend $2.1 billion annually advertising their brands. Nestle & Hershey alone in the last twelve months produced 1,163,990 metric tonnes of chocolate for the market (Mintel 2006). The budgets for health promotion and public health strategies pale in comparison.

[1.3] The integration of Oral Health into the primary school curriculum

The educational component of this developed computer programme supports the oral health strategy and attempts to integrate this into the school curricular programme. This

has shown itself to be an effective methodology for health messages to be delivered in the past (Chapman et al 2006, Kwan et al 2005). The decision to integrate the educational programme on oral health into the classroom was based on several factors:

- It could accompany the daily brushing programme at school.

- Access to a sample population of children within defined age ranges.

- The computer programme would be delivered in a controlled experiment.

- It would facilitate feedback and data collection.

The traditional method of delivery of dental health education materials in this setting comes from direct education from a nurse or hygienist visiting the school. Although effective in the short term the cost of running these school programmes was too high to justify the resultant benefits in caries reduction (Horowitz et al 1987, Wight and Blinkhorn 1988). Mass media campaigns have also been used with limited success (Friel et al 2002, Vanobbergen et al 2004). Teaching staff are not always in a position to deliver oral health education and are often happier to defer to health professionals to fulfil this role.

Studies have shown that in some cases the use of indirect teaching materials such as computer based programmes and audiovisual materials have been as effective in reducing plaque and producing behavioural change (Rodrigues et al 2003). These findings are supported by the successful use of computer based educational models for the control of asthma and obesity in adolescents and children (Liberman 2006, Krishna et al 2003).

The development of an interactive computer programme that is integrated into the curriculum would remove the responsibility of delivery from the teaching staff. Moreover, it would allow the content of the programme to be consistent and reliable and could be adjusted to comply with the principles of any ongoing oral health programme.

[1.4] Psychology of learning

To influence and affect behavioural change in an individual through education one must first understand how best to educate that person. The process of learning and education is a continuous one throughout life, constantly changing and evolving. It is well beyond the scope of this thesis to look at all the theorists work in depth. However, it is essential to understand the theoretical concepts that relate to the development of the interactive computer programme.

[1.4.1] A Brief history of learning

Many models of education have been proposed over the years, the theories were initially designed to improve the educational systems and better performance. B.F. Skinner (1904-1990) was one of the most influential behaviourists of the 20th century. His theories were based on operant conditioning or "rote learning", which encouraged learning through reward and positive reinforcement. Children often however find this repetitive and boring (Wiburg 2006). Dewey (1859-1953) saw the process of learning as an active one driven by new ideas and experiences. He considered learning to be linked inexorably with the social development of the child. His theories were some of the first to encourage problem based learning, were the educational merit was not in arriving at the correct answer but the journey to get there. Dewey's theories on educational process ran alongside the theories proposed at the time by Jean Piaget (Dewey 1897, Mooney 2002).

[1.4.2] Piaget theories on child development

Piaget (1896-1980) considered children to be innately gifted and active learners who were continuously experimenting with the environment, creating and testing their own theories of how the world works. As with Dewey, he stated that children construct knowledge and

learn through interaction with the world and with their experiences of social influence.

They learn and develop through exploration and play, and in this way discover how the world works and the basic laws that guide it. Developing the understanding of basic physical laws and the intricacies of social interaction is a complex and demanding process, especially if you are only five years old, and think grass grows so that if you fall you don't hurt yourself, that the sun follows you wherever you go and that big things sink.

Piaget proposed that children's thinking does not develop smoothly but in leaps that increase the child's capacity to comprehend the world (Piaget 1955). Prior to these stages the child would be, no matter how bright, incapable of conceiving the more developed cognitive processes of the next level. This allowed the division of Piagetion theory into four distinct stages, these are:

- The sensorimotor stage.

- Preoperational stage.

- Concrete operational stage.

- Formal operational stage.

Paiget's theories remain at the centre of constructive education. They have however been shown to be flawed by theorists such as Vygotsky who stated that children learn best not through independent exploration and investigation but through the structured learning guided by a more experienced partner (Verenifina 2004).

[1.4.3] Vygotsky, the zone of proximal development and scaffolding

Vygotsky's (1896-1934) seem the most appropriate of the educational theories upon which to base the interactive computer programme. They revolve around the idea of a zone of proximal development. This represents the difference between what the child can learn by

himself and what he can learn when assisted by a more skilled partner. The idea is to support learning through peers and teachers using "scaffolding" to deconstruct tasks into manageable segments. Each segment is just slightly beyond the child's current level of competence and is complementary to their existing ability (Doolittle 1997, Mooney 2002), stretching them and drawing them forward inexorably.

Vygotsky also recognised that development is intrinsically linked to the social and cultural content of the child's life. Ideas outside the context of the child's experiences and cultural environment are not understood therefore the cognitive process is linked intrinsically to the socio-cultural development of the child (Verenifina 2004, Anastasia and Vonèche 1996).

It is the blend of these theories that has lead to the educational systems present within our schools and therefore they should form the basis of the pedagogic profile that should guide the development of the computer programme, to complement the teaching styles utilised in primary schools today.

[1.5] Technology

[1.5.1] The impact of computer use on young children

Young children today are increasingly being exposed to computers both at home and in the school environment and an argument exists concerning both the advantages and disadvantages of this early exposure.

In a report produced for the Alliance for Childhood (2000) entitled, *Fool's Gold, a critical look at computers in childhood,* it is argued that childhood should not be hurried and what is appropriate for adults is not always appropriate for children. The report suggests that the use of computers could lead to: repetitive strain injuries, eyestrain and obesity. Diminished social contact could impact on the child's social, emotional and cognitive development. The risk of stunted language development, child isolation and lack of imagination and creativity were also cited (Alliance for childhood 2000, 2004). Clements, (1999) stated that children should experience activities and learning through physical rather than through symbolic activities. Concerns have also been raised about the inappropriate use of computers when alternative traditional methods are available, especially when this is seen as a form of entertainment rather than education (Henniger 1994).

However it must be remembered that many of these studies are conjectural and lack empirical evidence; nevertheless it does highlight the need for caution when implementing computer use in the classroom.

Conversely supporters of early computer use within the classroom refer to studies which show computers are developmentally appropriate and beneficial in the development of social and cognitive skills (Clements and Swaminathan 1995, Strommen 2000). It is obvious that the use of computers and technology cannot replace traditional teaching and

that technology itself cannot replace the physical interactions of play. However a growing understanding of children's educational requirements is helping create appropriate material that actively encourages interaction and social constructivist learning (Mandryk et al 2001, Clements 1999). The National Association for the Education of the Young (NAEYC) published guidelines in 1996 to help in evaluating the appropriate use of technology for the children (NAEYC position statement 1996). They concluded that:

> "Educators must use professional judgment in evaluating and using this learning tool appropriately, applying the same criteria they would to any other learning tool or experience."

The report also stated that the teacher's role is critical in deciding the appropriate use of the technology, and that when used appropriately would support and enhance children's cognitive and social abilities. It recognised that using computers could increase children's confidence and independence improving their communication and learning skills. This was especially relevant for children with special needs (Schery and O'Conner 1997).

[1.5.2] Computers in the classroom

The numbers of computers in preschools and primary one classroom's has risen dramatically over the last ten years to almost the point of saturation. The presence of this technology is now a reality but a question remains as how to best utilize this resource. Children show a pride and confidence in investigating new technology. Far from being isolatory and antisocial it can help nurture social interactions and help shy less confident children to participate, encouraging reflective thinking and learning (Clements and Sarama 2003). This is best achieved when the educational material can be integrated into the curricular demands and social context of the classroom.

This is of course dependent on appropriate design and development of the computer programme (Mooney 2002, Dewey 1897, Doolittle 1997). If this is poorly done, in the words of Clements and Swaminathan (1995):

" the same old teaching becomes incredibly more expensive and biased towards its dullest parts."   "New Lamps for Old?"

[1.5.3] Computers and control

Children learn best when they feel in control of the situation, setting themselves goals and solving problems. They can find this difficult initially but with structured support and guidance grow in confidence with time (Clements and Swaminathan 1995, Vilhjalmsson and Marsella 2005).The interactive computer programme is designed to provide this support and direction to the children's learning while remaining fun and engaging. Clements, (1999) showed this blending provides a strong and robust learning system, the mixture of activities adding to the educational benefit and the cognitive development of the children.

[1.5.4] Children's social interactions with computers

Strommen and Alexander, (1999) observed that the introduction of computers into the classroom did not affect the social dynamic. Children often worked in pairs on the computer in some cases enhancing interactivity. Andrews et al (2003) studied social interaction in a small group of four to six year old children using "thinking tags". The tags were LED lights worn by the children that went from green to red, if the children failed to care for their tags or "electronic teeth". The light would flash red for several minutes during which time the children could visit an electronic brushing station that would return the light to green. Failure to do this would render one of the child's five LED lights

permanently red which represented the development of a cavity. The children exhibited

positive peer pressure, showing concern for their classmates developing cavities and

assisting them resolve the problem. The study shows that children of this age comprehend

the concepts of accumulation and consequences and can act appropriately to prevent it.

[1.5.5] Computers effect on language development.

There are concerns that the isolatory nature of computer use would affect children's

speech and language development. Resnick, (2006) found no difference in children's

verbal development when using computers in schools. Children often sit in pairs or in

small groups whilst working on the computer. Where the level of verbal interaction is

normal, even when children work on their own on the computer they often engage in "self-

talk" which is talking to the computer explaining their actions to reassure themselves

(McCarrick and Xiaoming 2007). There is no evidence to show that using computers in an

educational environment impacts upon children's ability to communicate verbally.

[1.6] Difficulties in designing software for children

Understanding a child is the key to developing appropriate software. It is important to

consider what children find interesting and engaging and what they consider to be fun, and

not impose upon them what we feel they should enjoy or want to partake in. Our views and

memories of childhood are often a "skewed and idealized misrepresentation of the truth"

which makes thinking from a child's perspective difficult and designing for them

challenging (Sandburg and Samuelsson 2003). Children at this age have poor literacy skills

so no keyboard should be used. Abstract thinking is often beyond them and their thought

process is generally egocentric. All these issues have to be taken into consideration when

designing appropriate software (Bruckman and Bandlow 2002).

[1.7] Interactive components of design

[1.7.1] Rational for the development of an avatar

To help children understand the computer programme better, an "avatar" or animated vocal character was introduced to act as a guide. This removes some of the technological burden from the child without them relinquishing control (Price et al 2002). The avatar characters appearance could be based upon any image. The selection was narrowed to two options. The first to base the appearance on that of a child, utilising the empathetic reactions of children to help establish novel social and personal interaction. Evidence suggests that if a character is perceived to be similar to the user in appearance and behaviour, then greater empathic relations will emerge increasing active engagement in the subject topic (Hall et al. 2004). The alternative was to base the avatar upon an autonomous puppet agent, a pre-existing Oral Health Puppet, utilizing social mimicry as an interface strategy (Africano et al 2004). This would eliminate any form of gender bias from the character and allow a physical association with the programme through the actual concrete or physical presence of the puppet. It was decided to base the avatar character upon the existing Oral Health Puppet.

[1.7.2] Social interactions

Children learn through building on social experience, so endowing the avatar with human like attributes, allows the child to apply their understood rules of social behaviour to it. This should allow the avatar to perform better and be naturally more engaging. The guidance provided by the avatar allows the basic scaffolding structure of the program to be put in place (Verenifina 2004), whilst allowing the child to retain control.

Another key feature in human social interaction is the use of emotion, which can be inferred through, intonation in speech patterns and through facial expressions and

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movement (Hall et al 2004). The avatar character must show consistent emotional characteristics.

Children are comfortable with consistent and stable personalities and learn better when they can predict the character's reactions. This form of social reinforcement improves performance and motivation, it also creates the illusion of face to face interaction through the avatar (Oviatt and Adams 2001).

[1.8] Educational technologies

[1.8.1] Why make education a game?

Interactive computer programmes (games) have many attributes that distinguish them as excellent learning environments. They can provide complex problem solving exercises that allow for experimentation and learning through trial and error (Oblinger 2004). They allow children to explore safe and exciting environments actively seeking information and learning. Children understand games, they perceive the urgency in play, the satisfaction of success and the enjoyment of participation. Liberman, (2006) conducted a study of children from age six to eleven and found that 49 of 50 preferred learning using interactive computer games to video or book based learning stating, "it lets you try things out", the open format of games and the excitement and eager participation of children makes them a powerful teaching aid (Liberman 2006, Papert 1980). Integration of computer technology into education and the home is growing and its appeal with children of all ages obvious. With a market estimated worth of $31.6 billion annually it is a growing and influential media (PricewaterhouseCoopers 2008).

[1.8.2] Interactive programmes as pedagogic platforms.

Interactive programmes are considered effective learning platforms because of their immersive nature. These draw the player into the environment, forcing them to make decisions and to learn as a prerequisite to progress through the game (Skiba 2008a). The 2008 Horizon report lists games "pedagogical platforms" as one of the new emerging technologies in education. In light of this, certain descriptive criteria have been developed to help guide the production of educationally effective materials, these are best described by Oblinger (2004) and are summarized in Table 1.1.

The integration into everyday teaching and education at all levels can be seen in the representation of developing software and technologies. Yet this technology needs to be tested to see if it is appropriate for the situations in which we intend to use it. What are the advantages and will they outweigh the costs? The infancy of this field of research varies in its outcomes and there is a distinct requirement for further investigation into the use of interactive computer programmes as educational tools (Games for Health 2008).

Table 1.1 Principles of good pedagogy and parallels in an interactive game environment.

Principle	Description	Application in Games
Individualization	Learning is tailored to the needs of the individual	Games adapt to the level of the individual
Feedback	Immediate and contextual feedback improves learning and reduces uncertainty	Games provide immediate and contextualized feedback
Active learning	Learning should engage the learner in active discovery and construction of new knowledge	Games provide an active environment which leads to discovery
Motivation	Students are motivated when presented with meaningful and rewarding activities	Games engage users for hours of engagement in pursuit of a goal
Social	Learning is a social and participatory process	Games can be played with others (e.g. multiplayer games) or involve communities of users interested in the same game
Scaffolding	Learners are gradually challenged with greater levels of difficulty in a progression that allows them to be successful in incremental steps	Games are built with multiple levels; players cannot move to a higher level until competence is displayed at the current level
Transfer	Learners develop the ability to transfer learning from one situation to another	Games allow users to transfer information from an existing context to a novel one
Assessment	Individuals have the opportunity to assess their own learning and/or compare it to that of others	Games allow users to evaluate their skill and compare themselves to others

(Oblinger, 2004)

[1.8.3] The developing use of interactive technologies in health education.

The changing and broadening face of this evolving technology can be seen reflected in the new diversity of applications for which it is being proposed. The 1990's saw the first patient educational materials and these would include: asthma education; diabetes regulation and education; cancer education; urology/dialysis and spinal cord injury. A literature review by Lewis, (1999) identified sixty-six articles, between 1971 and 1998, including twenty-one research reports on the uses of computers to aid patient education. Many of the studies represented early evaluation studies and were descriptive or anecdotal in nature. Twenty-one studies looked at the educational potential for interactive programmes compared to traditional instruction, measured as knowledge improvement or clinical outcome. Fourteen of the studies were randomised trials, and only six related to children. It is these randomised trials that provide the greatest evidence for the use of interactive computer technology as an educational tool.

[1.8.4] Interactive technology verses traditional education material.

In studies comparing the effectiveness of interactive computer technologies compared to traditional educational materials there is a degree of disparity. Some studies recorded an improvement in both the intervention and control groups (Brown et al 1997 and Kreisel 2003) whereas others report an improved outcome for the intervention group alone (Wise et al 1986, Liberman 2001, Krishna et al 2003 and Serrano and Anderson 2004). One of the difficulties in comparing these studies is the diversity of the study designs and the variation in the outcome measures. The studies can be broadly categorised as those showing a significant improvement within the intervention group alone and those showing a significant improvement for both the intervention and control groups. Looking at the structure and design of these studies may help resolve the disparities in the reported effectiveness of the interactive computer technology.

[1.8.4.1] Trials showing improvement in both intervention and control groups;

Brown et al, (1997) and Rubin et al, (1986) both used computer interactive gaming technology within their studies. Both trials were significant for the use of the technology in relation to improved clinical outcome and awareness, for diabetes control and asthma regulation respectively. Neither study however showed a significant difference in acquired knowledge of the participants between the control and intervention groups. Brown stated this was probably due to the fact that the control patients were receiving excellent medical care, including comprehensive educational advice, "Caring for Kids with Asthma" provided by National Asthma Education and Prevention Programme.

Work by Kreisel (2003), supports these results, when evaluating an interactive programme designed to improve nutritional education in children aged eight to eleven. A significant improvement was seen in both the intervention group and control group using traditional educational materials. Kriesel attributed this to limitations within the study itself and commented on the difficulty in comparing studies within this field due to the variations of study design. Trials either compared the computer based programme against other educational materials, individually or as an adjunct to traditional materials.

[1.8.4.2] Trials showing significant improvement comparatively in intervention groups;

Wise et al, (1986) tested computer aided instruction in diabetic control against traditional instruction, measuring improved knowledge and clinical outcomes, the intervention group performed significantly better in both circumstances. Liberman, (2001), also found a significant improvement in diabetic youngsters self regulation, using interactive educational computer games which reduced hospital emergency attendance by seventy-seven percent, compared to no clinical reduction for a control group who were given an unrelated computer game. This study also shows positive impacts in relation to asthma

self-management. This is supported by more recent work by Krishna et al, (2003) who found that the use of an interactive computer programme to help control asthmatics, significantly improved the knowledge of the intervention group and reduced their symptoms and use of corticosteroid inhalers. In this trial both the control and intervention group were provided with traditional education materials in the form of verbal instruction and written information. The intervention group were provided with, in addition, an Interactive Multimedia Education Programme (IMPACT) which was available for use during the clinical visits. The programme allowed children to work through various symptomatic scenarios involving asthma control and regulation.

Serrano and Anderson, (2004), evaluated a computer programme designed for bilingual nutritional education for eleven year old children, the "Food Pyramid Game". This study assessed the effectiveness of the computer game in terms of improved knowledge, self-efficacy, attitude and behavioural intention. The results from the study showed a significant increase in knowledge and self-efficacy within the intervention group alone. The control groups in this study were provided with no additional educational materials and only completed the evaluation assessments pre and post test.

Several studies have used a multiple group trial design to evaluate the effectiveness of interactive technology against other forms of traditional education. These include Rodrigues et al (2003) and Ogolezak (1993), who compared the improvement in knowledge scores using leaflets, text-based computers and interactive computer devices. These studies found both the text based and interactive computer devices significantly more effective than the educational leaflet alternatives. Other studies have looked at gender race and socioeconomic status and found no significant difference.

The most notable difference in these study designs relates to the treatment of the control groups. There is considerable variation in the provision of educational materials provided. This ranges from comprehensive verbal and paper based educational materials to none at all. The variation in this provision could go some way to explaining the disparity in results achieved in the various trials. The general consensus amongst all the trials however points to interactive computer programmes being successful in imparting knowledge. Their effect on behavioural modification and effecting clinical outcomes requires further investigation.

[1.8.5] Interactive Oral Health and Nutrition Programmes

Holly's Kitchen and Teeth and Eating were some of the early interactive resources providing computer based oral health and dietary information to children from nursery school up to the age of twelve (Roebuck et al 2000). Holly's Kitchen was a nursery school based interactive computer programme developed to help improve children's ability to identify healthy and unhealthy foods. It utilised a click and drag system which allowed the children to place items of food into a healthy or unhealthy basket. Both the preliminary evaluation results and the subjective analysis of the programme were positive in relation to the use of interactive technology within this age group.

Rodrigues et al, (2003) compared several forms of interactive media in terms of their oral health educational potential. These included an interactive "Robot", PowerPoint presentations, model displays and visits form oral health educators. Rodrigues found the Interactive "Robot" to be significantly the most successful method of imparting the oral health message. This was favoured by the children due to the fun and interactive nature of the developed robot which provided verbal information and instruction to the children.

Kreisel, (2003) found a significant improvement in knowledge of eight to eleven year olds, related to food identification and nutritional understanding, after using a "computer based nutrition educational tool". It was also stated that the computer programme "made learning

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about nutrition more enjoyable, exciting and effective". This view is supported by the subjective analysis of an interactive nutritional education games by Brown et al, (1997) and Wei, (2007) that showed the participants enjoyed and engaged with the interactive nature of the programmes. The participants in both studies also displayed increased intention to modify their dietary behaviours.

Recent Interactive computer oral health programmes developed have included, "Natural Nashers", "Me and my mouth" and "Crunchy Croc" all of which have used interactivity in an attempt to improve their effectiveness and appeal to children. However, there is no research trial data available on their impact or success (Craft et al 1984, Crunchy the Croc 2007, SOHPAG 2007). The interactive format however has been well accepted into schools and nurseries, which are showing a growing acceptance of this form of educational multimedia.

[1.8.6] Recent developments in interactive education

As computers get faster and technology develops so the complexity and variety of the programmes being produced has multiplied. The last two years alone has seen the establishment of grants and funding research specifically designed to investigate the possibilities of interactive computer programming for health. The Robert Wood Johnson Foundation now supports the Health Games Research programme with over $8.2 million annually. This supports such research as K.I.C.K. (Kid's Interactive Creation Kiosk) developed to reduce stress for children waiting in A&E rooms and "Ditto", a multimodel distraction device being used to distract children undergoing invasive procedures (Spinweber 2008). The possibility that, the interactivity of games could lead to behavioural modification and manipulation has lead to investigations into the use of interactive computer programmes in reducing anxiety before, general anaesthesia and surgery (Campbell et al 2005, Rassin et al 2004). Improving motivation in chronically ill children

(Liberman 2001) and those suffering with diseases such as Sickle Cell and Cystic Fibrosis (Yoon and Godwin 2007, Starbright World 2008). These studies have all reflected positively on the use of interactive computer programmes in achieving beneficial results.

The most recent advancements have come from the development of new computer interfaces that allow the active participation of children in the programme itself. The evolution of technology such as the Wii, encourage physical exercise as part of the game interactivity. Wii applications such as balance mats are being modified to help recovering stroke and Parkinson's patients improve balance and coordination (Howell 2005, Skiba 2008b, Zigmond 2008). The integration of this technology is being widely encouraged in schools and homes in America to combat childhood obesity and promote active education (Brown 2006). The term "exergaming" describing the growing phenomena.

[1.8.7] Is interactive computer based education the way forward?

It would seem inevitable that the integration of technology into health education would lead us along the path of interactive computer programme development but the problem lies in the lack of evidence based material to support this shift. The psychology and pedagogic development of the educational material is critical and the delivery challenging. It is therefore essential to investigate the effectiveness of this technology and discover the limitations and benefits it may or may not offer.

[1.9] Summary of Literature review

There is a distinct need and requirement to deal with the levels of childhood caries within the Western Isles. The poor levels of registration and attendance have created a stagnant level of disease within the four to six year old age group. To help resolve this problem a reduction in cariogenic snacking should be encouraged along with toothbrushing and the use of fluoridated toothpaste. This would be best addressed through early preventative intervention and nutritional education.

The strategy best thought to deal with this is through primary education within schools, integrating oral health education into the school curriculum. Early intervention has been shown to improve children's attitudes towards health and general well being and improve long term outcomes.

The provision of educational resources utilizing interactive technology have been seen to be effective in increasing knowledge and improving behavioral motivation. The development of effective interactive educational software is dependent on the appropriate integration of psychological and technological theory.

The use of interactive computer programmes as pedagogic platforms has been seen to be effective in promoting health education. The implications for the use of this technology must be carefully assessed to determine the situations for which its application would be most effective.

Chapter 2

Aims.

Aims

[2.1] Primary aim

To develop and evaluate an interactive computer-based programme to teach children the difference between healthy and unhealthy foods.

[2.2] Secondary aim

To report whether the computer-based programme can positively influence the decision-making processes of the children in their choice of playtime snack or "play piece".

[2.3] Null Hypothesis

A computer-based programme will be no more effective in educating children about healthy food choices than traditional paper based materials.

Chapter 3

Interactive Computer Programme Development

[3.1] Introduction to Interactive computer design

The interactive computer programme was developed as a learning resource for four to six year olds. The intention was to provide a fun and interactive method for imparting an oral health message. The product was designed around attainment targets within the health and IT curriculum for schools in the Western Isles. The interactive computer programme allows the children to control the decision making process of an animated character, encouraging the selection of healthy foods.

[3.2] Development of the core programme

This chapter will look at the development strategies for the programme and the influences on its structure and content, and reflect on the psychology used to deliver the oral health message within the programme.

[3.3] Needs analysis

The needs analysis looks at the needs and requirements of the teachers and children in relation to the development of the interactive computer programme.

[3.3.1] Programme requirements for the adult

The teaching staff must have a programme that is easy to use, runs smoothly and which requires no additional software installation. It must be a programme the teachers are familiar with and comfortable using to allay any fears of new technology.

[3.3.2] Programme requirements for the child

The children's needs and requirements are at the core of the programme. Several factors had to be taken into account when developing a programme for children of this age.

[3.3.2.1] Dexterity

Children at this age can have some fine motor co-ordination problems, so it was decided the computer programme should use a point and click navigation system. Inkpen et al, (1995) showed the advantages of this in performance related computer tasks, the children finding the experience less frustrating and more enjoyable. The accessory programme "Catching Fairies" was designed specifically to improve the children's abilities in this area.

[3.3.2.2] Speech

It was decided that a natural voice with inflection and emotion would be recorded for the avatar. This was scripted to guide and instruct the children as they worked within the programme. Sentences would be refined to short succinct statements, allowing the child to focus on the primary objective of the statement and not become distracted by subsequent information. Scripting for children restricts the amount of information that should be conveyed within a single sentence (Kidd and Bavin 2002, Kaplan 1971).

[3.3.2.3] Reading

Limited reading ability at this age means the children are more dependent on the audio information within the programme. This is represented visually within the programme as abbreviated text, which gradually increases in difficulty as the programme progresses. The addition of text along with the spoken phrases helps the children with recognition of words and in the development of sentence structure and grammatical format. Key features in the development of higher thinking or abstract thought (Kidd and Bavin 2002, Kohnert et al 2005).

[3.4] Selection of an avatar for the computer programme

We based the avatar on a pre-existing oral health education puppet, which was given to the children along with the computer programme. The reflection of an established physical puppet within the context of the computer program has several advantages:

[3.4.1] The ideas of concrete manipulatives

The physical act of touching something for a child is important and there are close links between the physical perception of things and their reality in a child's mind. This is

because younger children have *Sensory-Concrete knowledge* and they often require physical connections to make mental associations. This develops into *Integrated-Concrete knowledge,* when the child dissociates the need for the physical presence simply replacing the physical with a conceptual idea (Clements 1999). The presence of the physical puppet helps establish concrete connections in the child's mind between the virtual computer avatar and the real world.

[3.4.2] Advantages in the use of a physical character to augment program interface

The computer screen can sometimes be seen as a barrier diminishing its effective use as an educational tool. The physical presence of the avatar represented as a plush toy or puppet can help younger children bridge the gap to the more abstract nature of the computer avatar. The physical presence of a sizable puppet also encourages tactile feedback, the soft and fuzzy side of social interaction. This produces positive pleasant feedback for the child associated with both the virtual and physical character.

[3.4.3] Use of familiar characters

The use of an oral health education puppet as the model for the avatar provides an instant frame of reference for the child to interact with the new form of media. The puppet character has familiarity and a distinct personality. The "para-social" intimacy shared by the child and the physical puppet extends to the computer avatar creating consistency in the social interface.

[3.4.4] Development of Play (freestanding) and Role play in reinforcement

The presence of the character as a plush toy provokes pretend play cues that are common to all children (Strommen 2000). Children interact with inanimate toys in a variety of ways that mimic social interactions. The play allows the children to explore social and

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collaborative interaction and often takes the form of role play. The puppet also allows for interaction away from the computer and can be used to introduce new topics, or even make children feel more at ease when visiting the dental surgery. It's always nice to see a friendly face!

[3.5] Development of the physical programme

Power Point was chosen as the programme platform as it was accessible to all the schools involved in the study and familiar to the staff. There are limitations to the degree of interactivity achievable, and other platforms such as Flash would be more appropriate. However, the use of Power Point as a "proof of concept" programme was thought to be the better option.

The content of the programme came from several sources. The "Childsmile", programme provided us with an insight into the direction and development of dental and oral health educational materials for the future. We combined this with the attainment targets for key level A as part of the 5-14 health education programmes and the individual school IT targets. This allowed integration of the programme within the classroom at the required level of complexity for the age group targeted (Health Education 5-14 National Guidelines 2000, Information and Communication Technology 5-14 National Guidelines 2000).

The salient features were:

[3.5.1] Childsmile Programme

- Brushing regularly and well.

- Importance of fluoride.

- Reduction in sugar intake.

- Hidden sugars within familiar foods.

- Reducing the frequency of snacking.

[3.5.2] Health Education Programme 5-14 (Level A)

- Identification of healthy foods/ unhealthy foods.

- Needs for the developing body.

- Being healthy.

- Staying safe.

[3.5.3] Information technology programme for 5-14 (level A)

- Learning to recognise the components of the computer.

- Accessing and using programmes (software).

- Using a mouse (hardware).

- Saving and recalling data.

A flow diagram was then drawn to see how the required features could be best incorporated into the programme (Figure 3.1).

The initial division of the programme to account for, age, ability and language, were introduced as concepts only. Further elements of the curriculum were also included within the flow diagram such as health and safety features but these were not developed. It was decided that the division between sexes was not required at this level of the study and with the small sample would be inappropriate.

Figure 3.1 Flow diagram of computer programme structure.
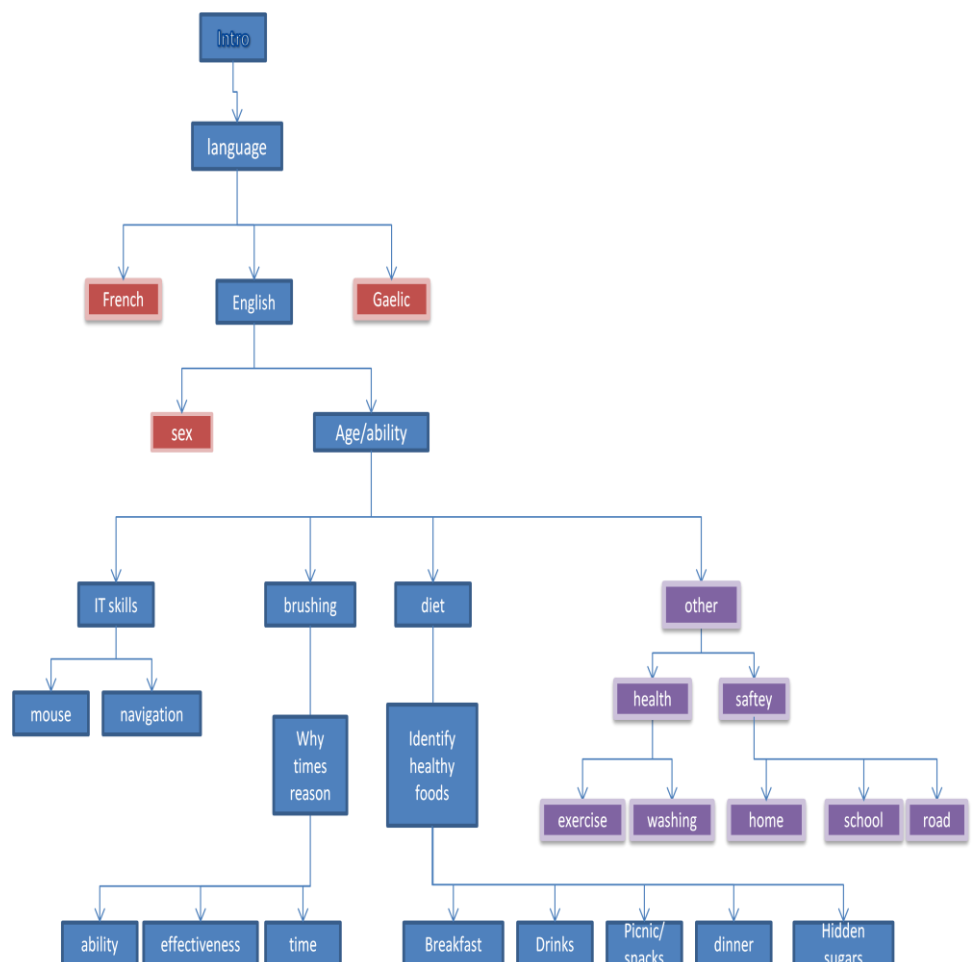
The story board was sketched firstly in pencil then animated characters were selected from a copyright free download site called Animation Factory. The main character of Barney the dog was a friendly and colourful character animated in several differing situations (Figure 3.2).

Figure 3.2 Barney the dog.

[3.6] Animation development

Other characters were included within the programme to increase the appeal for younger children, (Figure 3.3), along with numerous background features to create a colourful and bright environment. The background environment was kept the same throughout, as younger children established the context of the programme based on the relevant foreground details. A plain background was used and again taken from Animation Factory (Figure 3.4).

Figure 3.3 Subsidiary characters; Cat and Children.
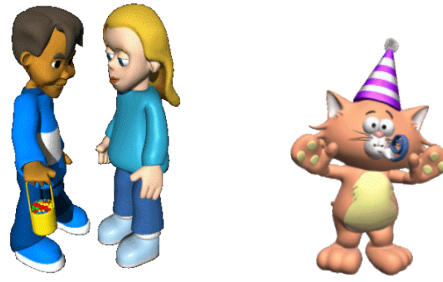
Figure 3.4 Plain background selected for programme.

The navigation buttons included within the standard screen are shown in Figure 3.5. These

navigation features were developed in accordance with Nielsen's heuristic analysis laws,

(Nielsen and Molich 1990). They are placed strategically to help develop the children's

natural navigation of the programme. The buttons were introduced gradually into the

programme and used only when necessary, they allow the children to investigate and

explore the programme content freely, gaining in confidence as they progress.

Figure 3.5 The basic screen including the navigation buttons.
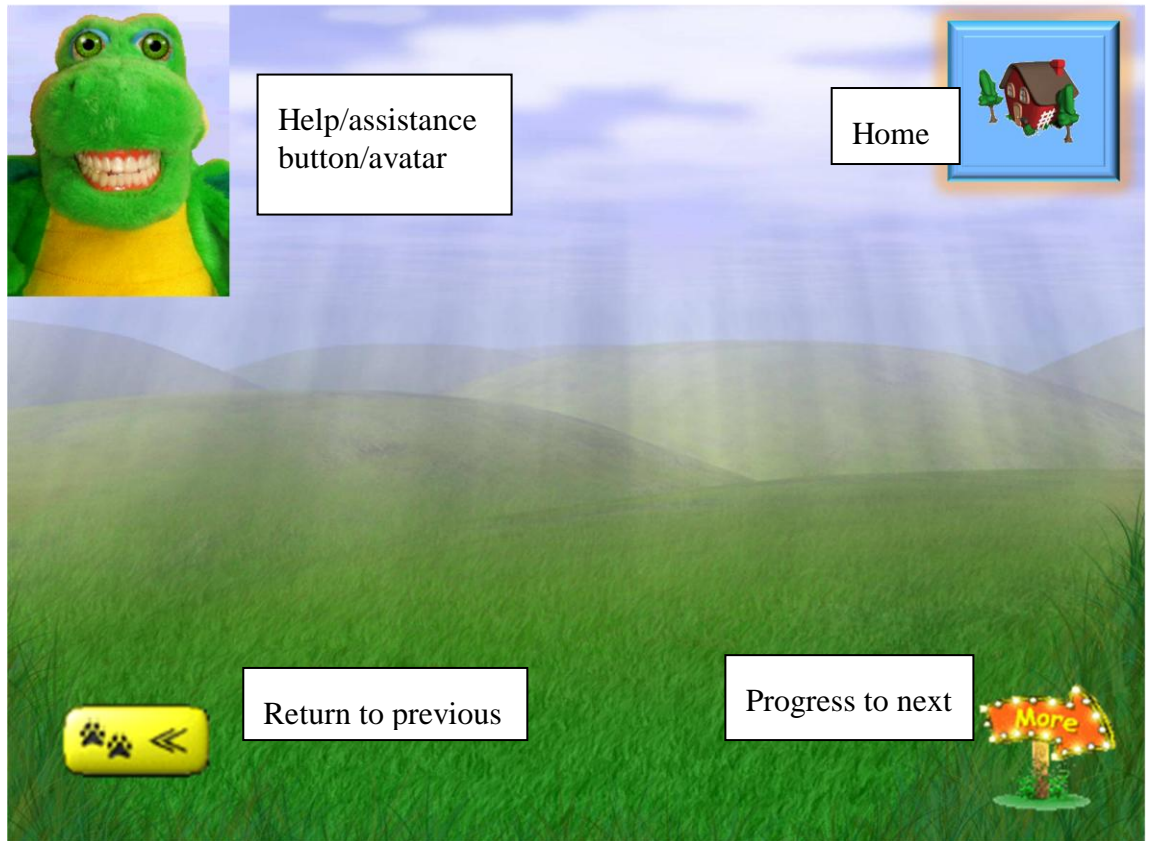
- ***Home button***: allows the user to return to the home or start page of the programme at any time.
- ***Return to previous***: this button returns the user to the last viewed page or to the beginning of the programme depending on which is appropriate. It is viewed as a regression button.
- ***Progress to next***: this button allows the user to progress to the next stage of the programme and could be either the next side or the next section. It is viewed as a progressive button.
- ***Help/assistance button***: this button provides relevant guidance for the appropriate stage of the programme and the instructions are verbal to allow for broader understanding of the programmes navigation system.

[3.7] Educational components development

The educational component of the programme was based on the correct identification of images of healthy and unhealthy foods. The correct selection of the healthy food would be rewarded with progression and further animation and the encouragement given was both verbal and visual. If incorrect selections were made there was no reward and the programme switched to a ubiquitous "wrong answer" screen and the child allowed to "try again". This was designed to discourage the children from choosing the incorrect answer simply to see what would happen. The positive reinforcement of the correct answer screens and progression through the programme was the incentive for the children.

The type of image to be used within the programme was important as children relate better to picture images of real objects than to drawings or cartoons. This should help the children retain the information better. Some images were photographed locally and enhanced digitally while others were obtained using FlickR Creative Commons (a copyright free information and image sharing website).

[3.7.1] Selection Presentation

Rather than present random images of food stuffs, the storyline asked the children to help Barney the dog "have a healthy day" by helping him choose healthy foods at meal times. The food types were chosen to reflect common every day food stuffs with an even representation of both healthy and unhealthy types. The food was presented visually as either a selection between five separate images or as a direct comparative selection between two options.

[3.7.2] Selection between five food options

As you can see from the flow diagram (Figure 3.6), when choosing between five options, the initial decision creates a cascade effect for each of the options available. The complexity of the process limits the number of initial options that can be successfully represented using this method.

Figure 3.6 Flow diagram of five choice selection cascade.
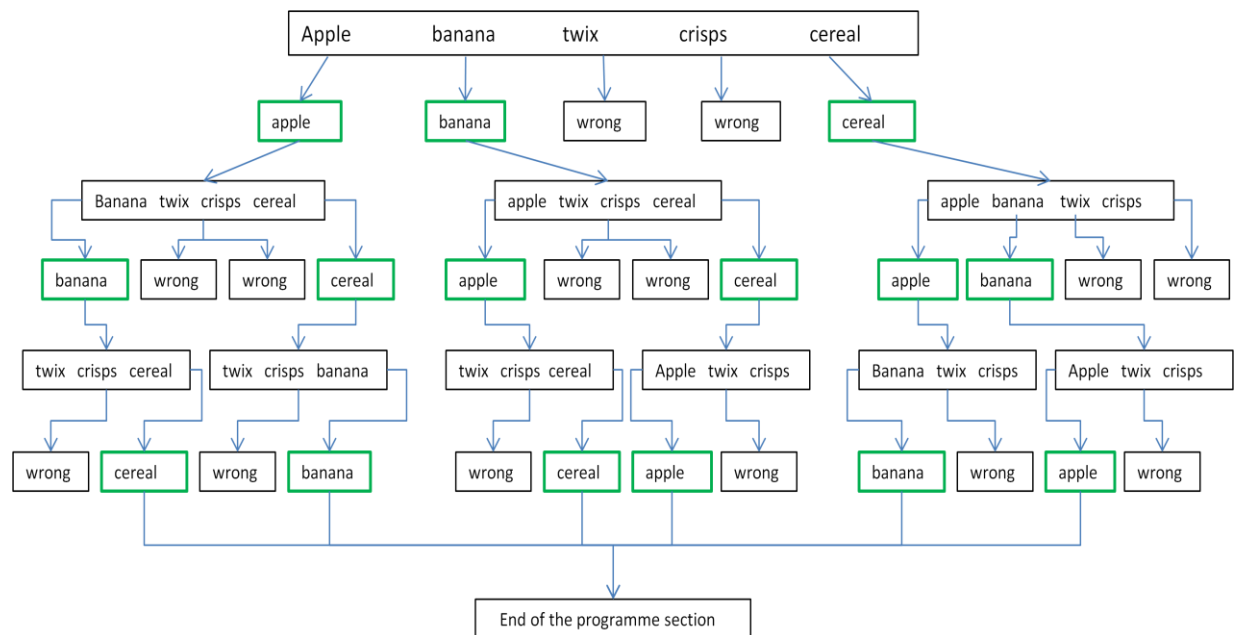
As you can see in Figure 3.7, the selection of the correct food stuffs leads to their removal from the options on the screen for selection. This will inevitably lead to only the unhealthy options remaining on the screen once all the healthy foods have been chosen. To reinforce the image of the healthy options at the end of the selection process the participants are reminded of the selections they have correctly made during the programme. This provides positive reinforcement of the healthy foods seen within the programme for the children before they continue to the next section.

Figure 3.7 The initial screen shot shows the food stuffs available for selection.
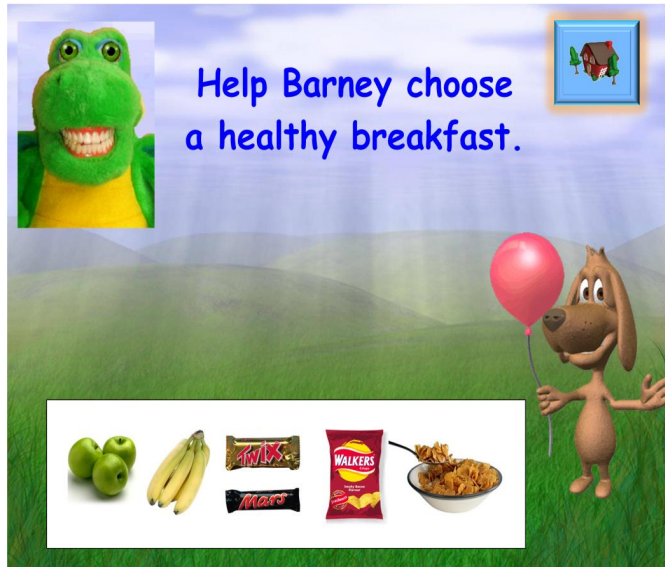
After selection of the initial healthy choice it is removed from the selection.

The final screen after selection of all the healthy foods reinforces the selection.

[3.7.3] Selection between two food options

The second method provided a choice between only two options at a time. In this way we avoid the complex cascading systems of the five choice options, but reduce the complexity of the decision making process (Figure3.8).

Figure 3.8 Flow diagram of two choice selection cascade.
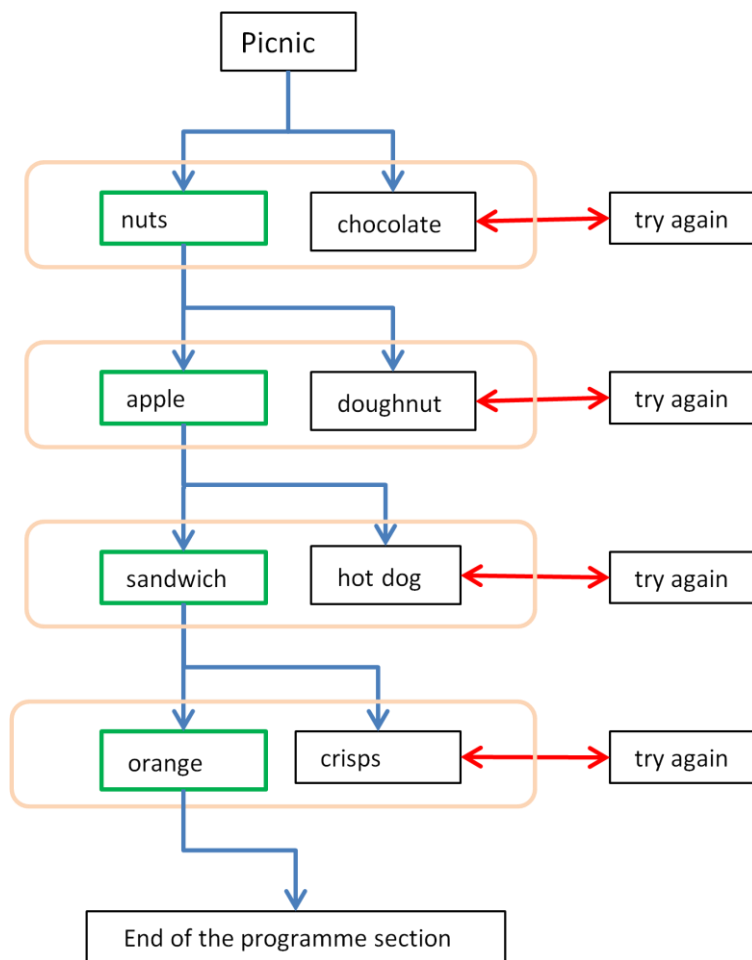
The simple comparative method (as represented within the programme in Figure 3.9) permits future alteration or extension of the programme content. The decision to incorporate both methods of presenting the data within the programme would allow us to assess the two formats to see which was more efficient and better received.

Figure 3.9 The two choice cascade system
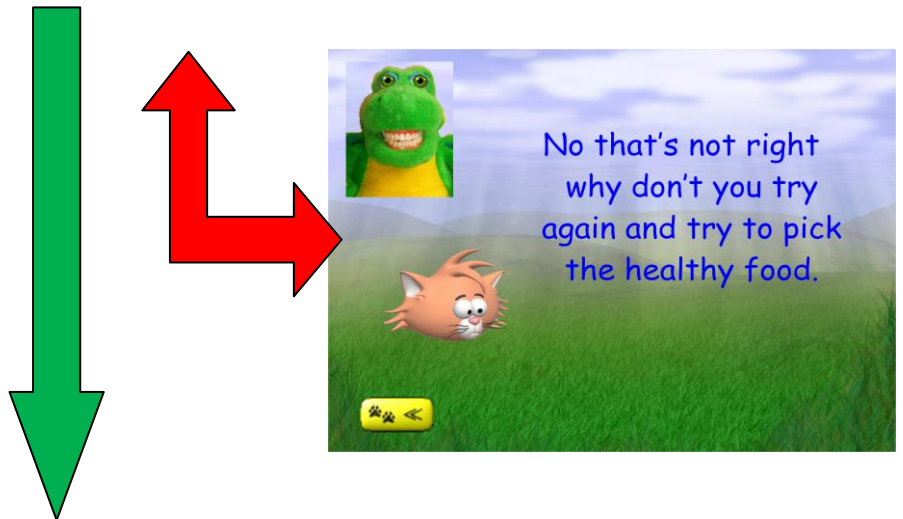
[3.8] Supporting "accessory" programmes

The accessory programmes were designed to reinforce concepts of modern oral health education. They focused on: brushing, the frequency of snacking and the importance of these in relation to oral health. The programmes allowed investigation of more complex subjects, which would have been difficult and confusing to deal with in the main body of the programme. They also helped support and develop the IT skills of the participants. The three supportive programmes that were developed to incorporate these ideas were:

- Catch a fairy.

- Tooth brushing.

- Snack safe.

[3.8.1] Catch a fairy

The "Catch a Fairy" programme was designed to improve the hand to eye co-ordination of children who are less experienced in using computers. The use of the mouse is essential in navigating the programme system and assessing the programme content, the development and refining of the fine motor skills required of this can be difficult for younger children. These concerns lead us to develop a small accessory programme that would allow the children to practise and develop their mouse skills in a series of simple games. The programme also included elements of the 5-15 school curriculum, which advocates the development of basic mouse interface skills for all young children as part of their IT education.

[3.8.2] Tooth brushing

The section of the programme entitled "tooth brushing" is designed to stress the importance of brushing on a regular basis, encourage healthy food selection and a reduction in snacking. The programme also introduces the concept of going to see the dentist and of brushing while at school during the day. These concepts relate to the expanding Childsmile programme locally.

[3.8.3] Snack safe

The main concepts within this section are: the problems associated with frequent snacking; importance of regular brushing; the use of fluoride toothpaste; and the understanding that high sugar content foods should be restricted to meal times. This is a more complex section and introduces difficult concepts for the children to understand. The verbal assistance from the avatar is reduced, increasing the requirement to read the more complicated text in order to progress thus making the experience more challenging and demanding.

The concept of the small image of the mouth relating to the oral health of the two characters was well accepted and understood. The physical representation of the mouth and of accumulation of bacteria "bugs", allows the children to investigate ideas of responsibility and consequences relating to their own oral health. This experimentation and investigation encourages participation and learning.

Remineralisation of the enamel surfaces through use of fluoride toothpaste is also a concept that lends itself well to a visual explanation. The idea of reversibility is complicated for children to understand, the use of words such as repair or fix make the concept more acceptable. It was important to introduce limitations to this, and reinforce the idea of permanent damage occurring from the accumulative effects of poor brushing and frequent snacking.

[3.9] Avatar development

To create the computer avatar character several systems were investigated. The most effective and practical was *Crazy Talk*. This programme allowed the manipulation of digital images to produce animated talking characters that allowed the expression of facial emotion and fluent synchronised speech. The programme was also compatible with *Power Point*. Digital images of an oral health puppet (Figure 3.10) were used to create the avatar for the programme. This immediately established a familiar context for the programme and created a character link to the real world from the virtual computer programme.

The puppet was designed to appear non-threatening and docile, even though it has huge teeth. To increase the appealing features of the puppet the image was sharpened and given digital animated eyes. The background of the image was also replaced with one which would blend better into the fixed background chosen for the programme (Figure 3.11).

[3.9.1] Vocal recording

The voice of the avatar was provided by the researcher and the script was digitally recorded as *wav* files. These files were then imputed into the Crazy Talk programme to create the illusion of the talking animated avatar.

Figure 3.10 The original digital images used in development of the avatar.

Figure 3.11 The adapted and digitally enhanced animated version of the final avatar.

[3.10] Conclusion

The combination and requirement for these elements within the programme directed the way in which the programme developed. The next stage of the development process was to expose the programme to both a peer and user groups, to further refine the production and tailor the content to a suitable level for the target audience.

Chapter 4

Qualitative study: Dental team, Dieticians and School teachers

[4.1] Aim

To assess the prototype interactive computer-based programme, in respect to:

- Functionality and practicality.

- Use of interactive verbal guidance and instruction.

- Ease of use of the navigation system within the programme.

- The suitability of scripting and content of the oral health messages.

[4.2] Method

[4.2.1] Peer group

The prototype interactive computer programme was shown to six members of the staff of Glasgow University Dental School. These included four paediatric dentists, a public health dentist and a dental therapist trainer. They were asked to assess the dental component of the programme.

The package was also reviewed by two local dieticians within the Western Isles, who were asked to view the programme with respect to nutritional aspects of the content.

Finally, two local teachers were shown the programme and asked to assess the suitability of the educational content of the programme and its presentation and navigational components.

The participants were allowed to use the programme, under the supervision of the researcher, for approximately 10-15 minutes, this is the longest time permitted for continuous computer use for children of this age. All the results were recorded on a questionnaire, Appendix 1.

[4.2.2] Structured one to one interview

Each participant then underwent a structured one-to one interview. The questions are shown in Appendix 2. The questions were short open answer questions designed to both assess the impact of the programme, its interactivity, and any problems or concerns which could may have been overlooked in the development.

[4.3] Results

The following are a summary of the salient results. They are recorded in the order of the most frequently mentioned responses.

[4.3.1] Results from the dental staff

- The programme takes too long to complete in a single sitting.

- Navigation buttons often not required for each screen.

- Some conflicting messages with script *versus* text.

- Healthy food alternatives should be better represented.

- The text should be more closely aligned to the script.

- The slide transfer rate should be faster and smoother.

- Slides are sometimes too busy.

- Reduce the number of choices to two as five options are distracting.

- Increase the 'help' component provided verbally.

[4.3.2] Results from the dieticians

- The programme takes too long to complete.

- The food choices should be made in context of the entire diet.

- Healthy alternatives should be better represented.

- The slide transfer rate should be faster and smoother.

- There are discrepancies in correlation between the text and script.

- Increase the number of slow release carbohydrates represented.

[4.3.3] Results from the teaching staff

- The programme had to be started and finished within one sitting which took too long.

- Navigation button to skip slides for more experienced users.

- Closer co-ordination of verbal script and text.

- Integration of key words from the curriculum to introduce topics/ideas.

- Individual access passwords for the children and saving their place to continue later.

- Way to automatically start the programme on insertion of the disc.

The results and ideas developed through the structured interview have been correlated in Table 4.1, in order of the most frequently mentioned and what would be considered the most important elements of the programme:

Table 4.1 Correlation of important elements derived from structured interviews.

	The topics which required consideration and alteration ranged from
Function	The programme had to be started and finished within one sitting which took too long
	Should try to increase the slide transfer rate and smooth the transfer
	Reduce the number of choices to 2 as 5 options could be distracting
Interaction	Increase the help component provided verbally
Navigation	Navigation system to increase transfer slide rate for experienced users
Script and content	Conflicting messages with script *versus* text
	Integration of key words from the curriculum to introduce topics/ideas
	Food choices should be representative of the entire diet
Miscellaneous	Healthy alternatives should be better represented
	Individual access passwords for the children and saving their place to continue later
	Find a way to auto run the CD

[4.4] Discussion

[4.4.1] Function and practicality

[4.4.1.1] Time constraints

The length of time taken to complete the programme was problematic due to the restrictions which set a period of 15 minutes maximum, for computer use within any one sitting, as dictated by the educational department. Therefore, the format must be arranged to allow access to varied levels of complexity within the programme. There are two methods of achieving this goal:

1. Allow the participant to save or store the position they achieve then continue at a later date.
2. Allow different levels of access at points in the programme.

We were unable to save and store the position of the participant within the programme.

 However, the use of separate sections within the programme worked well as each successive section could be made longer and more complex, the more experienced the user becomes. This allows the user to become familiar with the format and confident in manipulating the programme before having to address more complicated issues in the content. It also allows the user to repeat sections and choose their own rate of progression at their level of confidence. Allowing the user to control the flow of the programme also encourages their participation and engages them, which should be beneficial to the learning process.

[4.4.1.2] Slide progression

The improvement of the slide change and integration of rich media was sometimes slow or erratic within the programme. This was in part due to the compression format of the media files which was later changed to a more compact and smaller file size. The refinement of the slide transfer rates and non linear aspect of the programme content was improved with experience working with the product. The end product works to the limitations of the programme itself and further development would require the use of a different programme platform such as "Flash".

[4.4.1.3] Interaction

In some instances it was thought that it would be required to increase the amount of verbal assistance and interaction provided by the avatar, as some of the slide transitions and navigation features were not fluent enough. This was mainly due to the slow transfer rate of the slides and was resolved by increasing speed of slide transition and the rate at which navigation objects appeared on the screen.

[4.4.1.4] Navigation system

It was thought that the presence of some of the navigation features were not required in many situations. It was presumed that the presence of the options would be distracting and encourage inappropriate use. The removal of these features helped with the direction and flow of the game by reducing unpredictable responses.

[4.4.2] Script and content

[4.4.2.1] Alterations to the text and vocal script

There were several conflicting text statements in the programme when it was compared to the written content of the scrolling programme. These consisted of simple errors within the text which would be misleading or confusing when taken in context with the verbal script and were easily corrected. The correlation between the text and verbal content was important as children who are developing reading skills have an expectation that the text would closely follow the narrative. This forced further refinement of the scripting that would have to be used to explain relatively complex issues as the programme developed.

[4.4.2.2] Representation of healthy alternatives

Some content of the programme was thought to be too heavily skewed towards the elimination of unhealthy options rather than showing the healthier. To avoid emphasis on the presence of the unhealthy foods, it was decided to try and evenly represent the food groups. Ensuring that the last images were always healthy options to reinforce their image to the children. The food pictures themselves were chosen as they showed attractive images of the favorable food groups to make the options more appealing.

[4.4.2.3] Introduce topics/ideas

The introduction of key words and topics into the text and scripting was attempted on a small scale to see if it would be a successful methodology of introducing topics in a classroom situation. The use of words such as "vitamins and minerals" and the pictorial representations of links to sources of food production as seen in the section devoted to drinks, shows an attempt to develop this scenario. The verbal reinforcement of these ideas also allows the development of more complex ideas which the children would be incapable of comprehending from written text.

[4.4.3] Miscellaneous

Several other suggestions were put forward to integrate into the programme. They proved too complicated to integrate into the programme in its present format, these were:

- Individual access passwords for the children and saving their place to continue later.
- Linking to external information resources and websites.

These would be developments that could be integrated into the core of any future programme to improve its user friendliness. But for the purpose of this trial were beyond the remit of the development.

[4.5] Resultant changes to the programme

[4.5.1] Functionality and practicality

The programme took too long to complete and to solve this problem the structure of the programme was altered. The linear pattern (Figure 4.1) was changed with the addition of a different start screen. This screen acted as a hub for the programme from which the individual sections could be accessed. This required aspects of the programme navigation system to be altered. The new flow format can be seen in (Figure 4.2) and the representation within the programme can be seen in (Figure 4.3). This shows the alteration of the original linear format and construction of the start page or hub of the interaction from which the user can access the programme content.

[4.5.1.1] Smooth and quick transfer rate

The slide transfer rate was improved as much as possible by altering the video compression format and reducing slide animation complexity.

[4.5.1.2]Navigation system

The home page or hub of the programme also allows free decision making on the child's part and allows them to explore the environment themselves in a less structured manner thus giving them greater control and increasing responsibility.

[4.5.2] Script and content

Conflicting text statements were removed. This required the alteration of script details and re-recording to improve the coordination between the script and provided text and to correct any contradictary phrases within the programme.

[4.5.2.1] Introduction of topics and ideas

Specific curriculum details and topic introductions were incorporated through key phrases at this stage. Simple key words such "vitamins and minerals" and inclusion of water cycle and where milk comes from, these all introduce topics for discussion for the teachers.

[4.5.2.2] Representation of healthy alternatives

Alterations were made to the programme to reflect an even distribution of healthy and unhealthy foods where possible and there was an increase in the number of healthy alternatives represented.

[4.5.3] Miscellaneous comments

The ability to save the place the child had accomplished or create individual access rights is unfortunately beyond the ability of the programme and the programmer. The inclusion of the central point or hub to the programme would however create a similar effect, the child simply continuing after each session from the point they had left off previously without having to repeat the previous sections.

Figure 4.1 The original programme linear format.
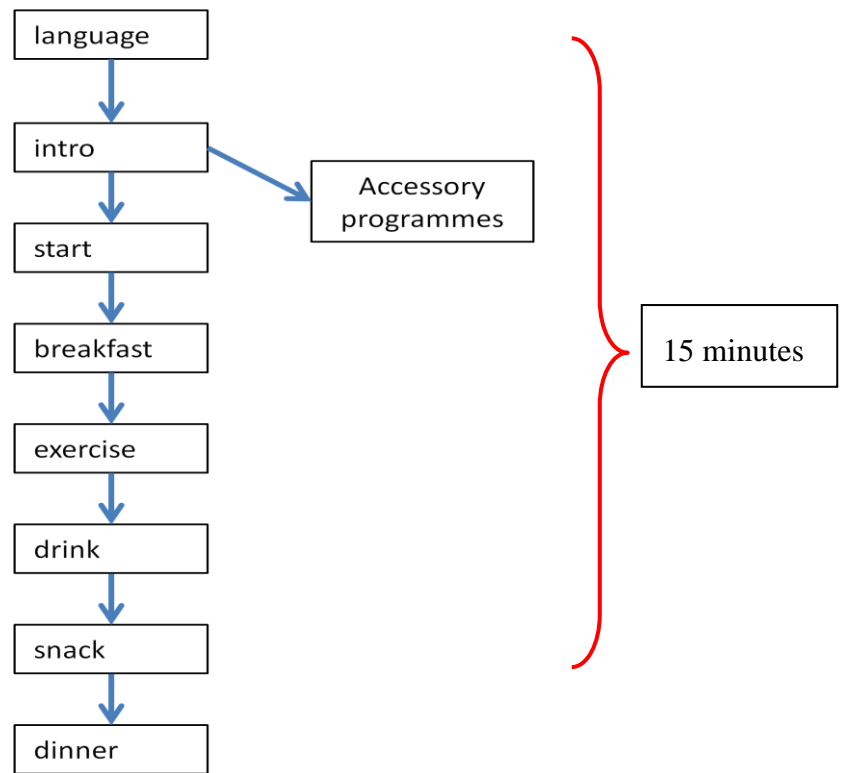
Figure 4.2 The revised programme format to accommodate time restraints.
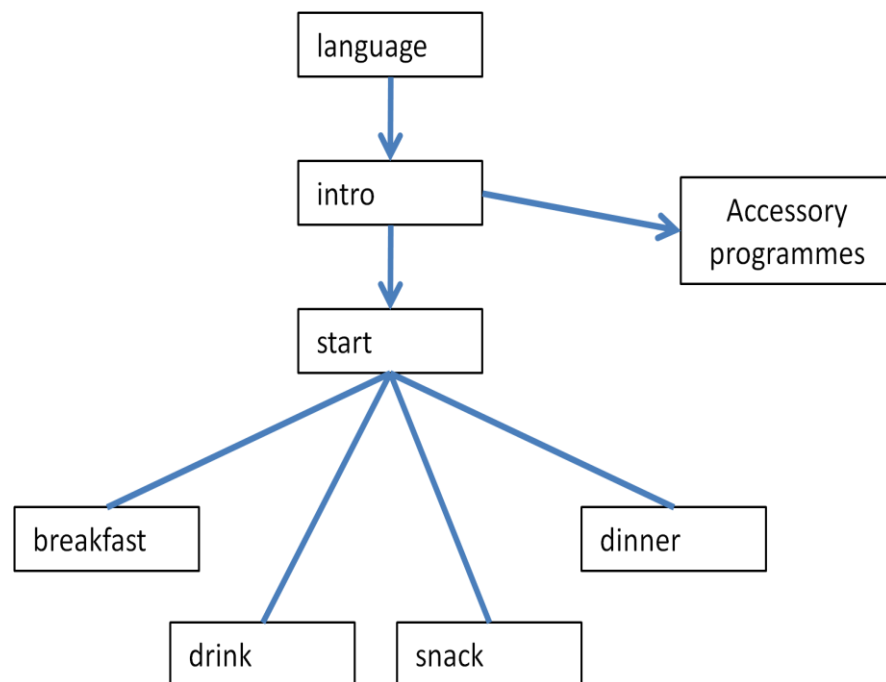
Figure 4.3 The screen representations of the revised format.

[4.6] Conclusion

The avatar based verbal instruction and navigation system, was adequate to successfully interact with the programme and was relatively instinctive. The alterations to the programmes linear format required further refinement to the navigation system which was successfully completed.

The refinement of the content and tailoring of the oral health message for the target age group was thought to be appropriate and would be further investigated at the user group stage.

Chapter 5

Qualitative study: User group assessment

[5.1] Aim

The aim is to evaluate the interactive computer-based programme in a school environment with the target age group in respect to:

- Functionality.

- Interactivity.

- Navigation.

- Script and content.

- Engagement.

[5.2] Method

[5.2.1] Sample population

A user group was composed of four to six year old pupils from Sandwick Hill Primary
School. This is a local Primary school out with the catchment area for the future controlled
trial. The children were introduced to the computer programme as part of an oral health
talk and were asked to use the programme individually for one week, under observation.
Afterwards they were invited to sit as a group with the researcher and their teacher to
discuss the programme in a structured interview.

[5.2.2] Functionality and practicality

The teacher was provided with several copies of the programme, in its prototype state, for
the children to use. Instructions on the use of the programme and how to deal with any
glitches within the programme were given to the teacher. The teacher was provided with a
form (Table 5.1) to record any irregularities or errors within the content. The children used
the programme individually and help was only provided if they became confused.
Otherwise they were allowed to use the programme freely. The children were allowed 10-
15 minutes of computer time at one sitting only before returning to class work. The
programme was run for one week before reassessment.

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[5.2.3] Assessment by direct and recorded observation

The interactions of the children with the programme were assessed using four simple criteria;

- Interactivity.

- Navigation.

- Script and content.

- Engagement.

The children were observed directly by the researcher, Colm Rice, on two separate occasions; on the first day and last day of the trial period (day 1 and day 7). Observations by the teacher were continuous during the entire trial period. Interaction was gauged through both direct visual observation and observed interaction of the children.

Direct visual observations: were made as the children worked their way through the programme included behavioral responses, intonations and unexpected reactions to the programme.

Observed interactivity: the children's interactivity with the programme was also assessed using a simple structured series of criteria shown in Table 5.2. This was designed to highlight differences and record interactivity for each of the different age groups involved in the trial.

Table 5.1 Table used by the researcher to record errors in the programme function.

question			section	comments
Interactivity	Problems using the assistance/help			
	Comprehension			
Navigation	Lost links			
	Slide changing problems			
	Jumping, skipping or sticking			
Script and content	Lost/confused			
	Text content too complicated			
Engagement	Enjoyable/fun			
	Bored easily distracted			

Table 5.2 Table used by the researcher to record the interactivity of the children with the programme.

Direct observation questions	Age group	P1	P2	P3
Interaction	Avatar			
	Programme			
	Puppet			
Navigation	Simple/instinctive			
	Confusing/complicated			
Script & content	Understood			
	Too complex			
Engagement	Enjoyable			
	Bored/ easily distracted			

[5.2.4] Structured interview with the teacher

Following the trial period a structured interview with the teacher was carried out to assess the functional and practical application of the programme and its limitations within the classroom setting. The teacher was also asked to comment on the suitability of the educational content of the programme.

[5.2.5] Structured interview with the children

After the trial period the children sat as a group to discuss the programme with their teacher and give their opinion of the programme and suggestions on how it could be improved. Their comments and suggestions also related to the complexity of the navigation system and the difficulty of the overall content. The children provided an insight into the level at which the programme content would have to be set and how they perceived the interactivity.

[5.3] Results

The results have been separated into three sections:

1. Functional concerns relating to the programme.

2. Direct visual observation of the children.

3. Structured interviews with teacher and children.

[5.3.1] Results from Functionality

The children evidently found some of the developed sections more enticing than others and would return to the same material repeatedly slowing their progression through the entirety of the programme. These sections included the greatest animated content and were too distracting for the younger children.

The older children found the programme too simple and not challenging enough. They completed the programme quickly and became bored and more easily distracted when repeating it.

The programme itself worked reasonably well and proved to be reasonably reliable. Some errors became apparent and were recorded.

An example of an error record sheet (Figure 5.3) includes, specific error points in the programmes continuity, general questions about content, and allows for comment to expand on topics or give advice on improvements.

Table 5.3   This table shows an example of recorded computer errors.

question		section	comments
Interactivity	Problems using the assistance/help	no	Better explanation of navigation system initially
	Comprehension	Ok	
Navigation	Lost links	oranges	
	Slide changing problems	23/127	
	Jumping, skipping or sticking	Drink/coke	
Script and content	Lost/confused	P1	More verbal direction for younger children
	Text content too complicated	simple	
Engagement	Enjoyable/fun	yes	
	Bored easily distracted	no	

There were 32 recorded errors mainly relating to incorrect slide progression on selection

and inappropriate selection due to open links which should not have been present and

accidental use of the hidden control buttons. All these problems were minor in nature.

[5.3.2] Results from the direct visual observation

[5.3.2.1]Interaction

The younger children watched and listened to the avatar while it was speaking and after implemented the actions that were required. The older children listened to the avatar and read the text but seldom looked at the avatar.

Some younger children also held the puppet whilst listening to the programme and would sit it in a position where it could also observe the PC screen and in one case talking to it whilst questioning an aspect of the programme.

All the children seemed to enjoy the novelty of the talking programme and the interaction and decision making process. The children had little difficulty in thinking through the third person. Surprisingly few tested the boundaries of the programme by choosing incorrect options on purpose to see the results.

[5.3.2.2]Navigation

The navigation of the system seemed quite intuitive to the children. Some of the younger children enjoyed using the mouse control practice game to improve hand-eye coordination. After only using the programme once the children would often anticipated where the button they wished to select was going to appear. The 'home' and 'advice' buttons were easily used but created confusion on a few occasions. The 'return to previous button' was placed too close to the hidden buttons within the power point programme. Due to poor mouse coordination, sometimes the hidden buttons would be selected by mistake knocking the programme out of sequence.

[5.3.2.3] Script and content

The script was clear and the instructions appeared easy to follow for the children. No words were too complicated and the grammar and vocabulary were at a reasonable level. The inclusion of key discussion words and topics was accepted well. The content however was set at too low a level for the older children who found the questions simple and unchallenging. The children did enjoy the supplementary programmes even though they were, by their nature, slightly lacking in interactivity (tooth brushing). They were found to help with the introduction of key topics and ideas to the class.

[5.3.2.4] Engagement

The children enjoyed using the programme and the interactive component seemed to hold their interest well. They liked playing with the programme in pairs, often teaming up a younger child with one more experienced on the computer. Their attention span whilst using the package extended beyond the fifteen minute maximum time allowed on the computer. They rarely became distracted and worked well concentrating on the activities.

[5.3.3] Recorded results from observed interactions

The results from the direct observations of the children are recorded in table 5.5,5.6 and 5.7. They represent a summary of the interaction on day 1, and on day 7 of use with the programme for the three different primary school classes.

Table 5.4 Recorded results from direct observation on Day 1 and Day 7.

	Age group	P1	P2	P3
Interaction	Avatar: Day 1) laughing, watching, listening, high levels of concentration *Day 7) Less watching still listening, lost initial novelty value*			
	Programme: Day 1) easy, good *Day 7) good, concentrating well on topic*			
	Puppet: Day 1) yes initially, distracted by programme *Day 7) increased, more girls than boys*			
Navigation	Simple/instinctive: Day 1) OK *Day 7) better more instinctive*			
	Confusing/complicated: Day 1) sometimes *Day 7) rarely now*			
Script & content	Understood: Day 1) some confusion about the selection process *Day 7) coping well*			
	Too complex: Day 1) depending verbal content *Day 7) trying to read more*			
Engagement	Enjoyable: Day 1) yes *Day 7) yes*			
	Bored/ easily distracted: Day 1) interested, concentrating *Day 7) average, distracted*			

This table shows the recorded results for direct observation of the interaction of the Primary 1 children with the computer programme at day 1 and day 7 (Day 7 recorded in blue italics).

Table 5.5 Recorded results from direct observation on Day 1 and Day 7.

	Age group P1 P2 P3
Interaction	Avatar: Day 1) observing and listening well *Day 7) less observation more listening and predicting response*
	Programme: Day 1) good *Day 7) predictable too easy*
	Puppet: Day 1) little interaction *Day 7) little interaction*
Navigation	Simple/instinctive: Day 1) progressed well *Day 7) good needs to be quicker*
	Confusing/complicated: Day 1) no *Day 7) no*
Script & content	Understood: Day 1) yes simple *Day 7) too simple*
	Too complex: Day 1) no *Day 7) not enough*
Engagement	Enjoyable: Day 1)yes *Day 7) yes*
	Bored: Day 1) no maintained interest *Day 7) repeating content decreased levels of interest over time*

This table shows the recorded results for direct observation of the interaction of the Primary 2 children with the computer programme at day 1 and day 7 (Day 7 recorded in blue italics).

Table 5.6 Recorded results from direct observation on Day 1 and Day 7.

	Age group P1 P2 P3		
Interaction	Avatar: Day 1) good novelty value, observation from interest not required for function. *Day 7) listening little observation good concentration*		
	Programme: Day 1) good *Day 7) predictable too easy*		
	Puppet: Day 1) interaction joking nature *Day 7) none*		
Navigation	Simple/instinctive: Day 1) yes did well *Day 7) mastered easily*		
	Confusing/complicated: Day 1) no *Day 7) no*		
Script & content	Understood: Day 1) too easy *Day 7) too easy*		
	Too complex: Day 1) no *Day 7) no*		
Engagement	Enjoyable: Day 1) yes *Day 7) should increase difficulty*		
	Bored: Day 1) no *Day 7) should increase complexity*		

This table shows the recorded results for direct observation of the interaction of the

Primary 3 children with the computer programme at day 1 and day 7 (Day 7 recorded in

blue italics).

[5.3.4] Results from the structured discussion with the teacher

The most salient features arising from the discussion with the teacher were as follows:

- Children repeatedly choosing the same option i.e. picnic.

- Too easy, so requirement to increase complexity of the programme content.

- Insert higher access controls for teaching staff.

- Increase the speed of slide transition.

- Debug / remove glitches from programme.

[5.3.5] Results from the structured discussion with the children

The main points that arose from the discussion with the children and teacher after using the programme are summarized below:

- Too easy, so requirement to increase complexity of the programme content.

- Have a button to skip things.

- Have the avatar talk more.

- Increase the speed of slide transition.

- Fix the broken slides (slipping transitions).

- Make the dog; superman or a cowboy.

- Make Mark (peer) the dog, then he could eat things.

[5.4] Resultant changes to programme

*[5.4.1] Functional changes to programme format*

It was apparent with the user group that children were drawn to one particular section of the programme and would repeat that section and not explore the other content sufficiently. To correct this problem the sections would have to be accessed in sequence. The time would only allow for three sections to be linked consecutively, this restricted increasing the complexity of the programme for the older children. As apparent in (Figure 5.1) the red area indicates the area of increased difficulty but unfortunately takes more than 15 minutes to reach so could never be completed within the allotted time frame.

Figure 5.1 Flow diagram of sequenced programme format.
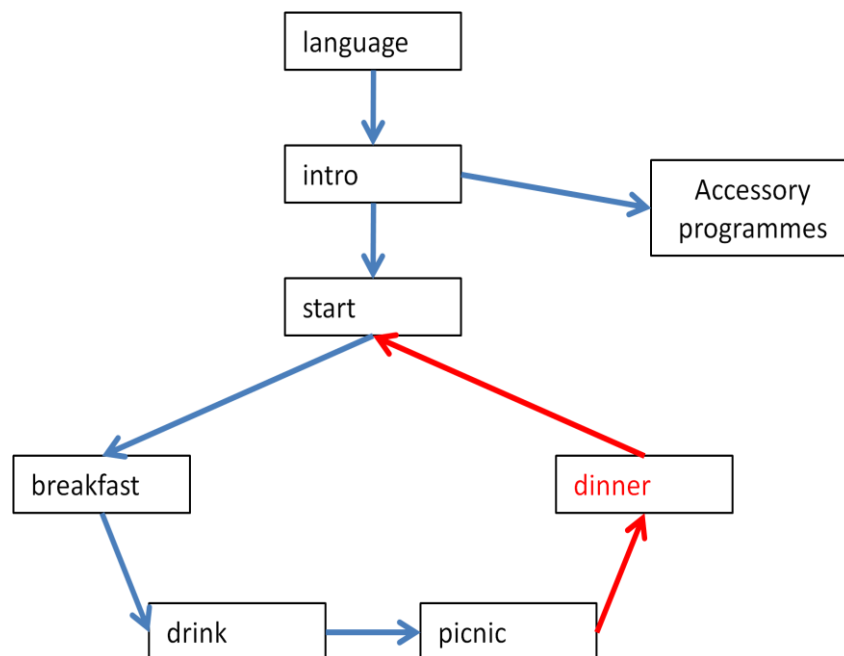
The solution to this problem was the further division of the programme content into two distinct sections one easy level for the younger children or less computer literate and a harder section for the older or more experienced children. The developed flow chart for this can be seen in Figure 5.2. At this stage of the programme the two levels were linked through the accessory programmes which would allow progression to the higher level or through the main easy/hard option screen.

Figure 5.2 Flow diagram of revised sequence dividing the programme into two distinct sections including Easy/Hard division.
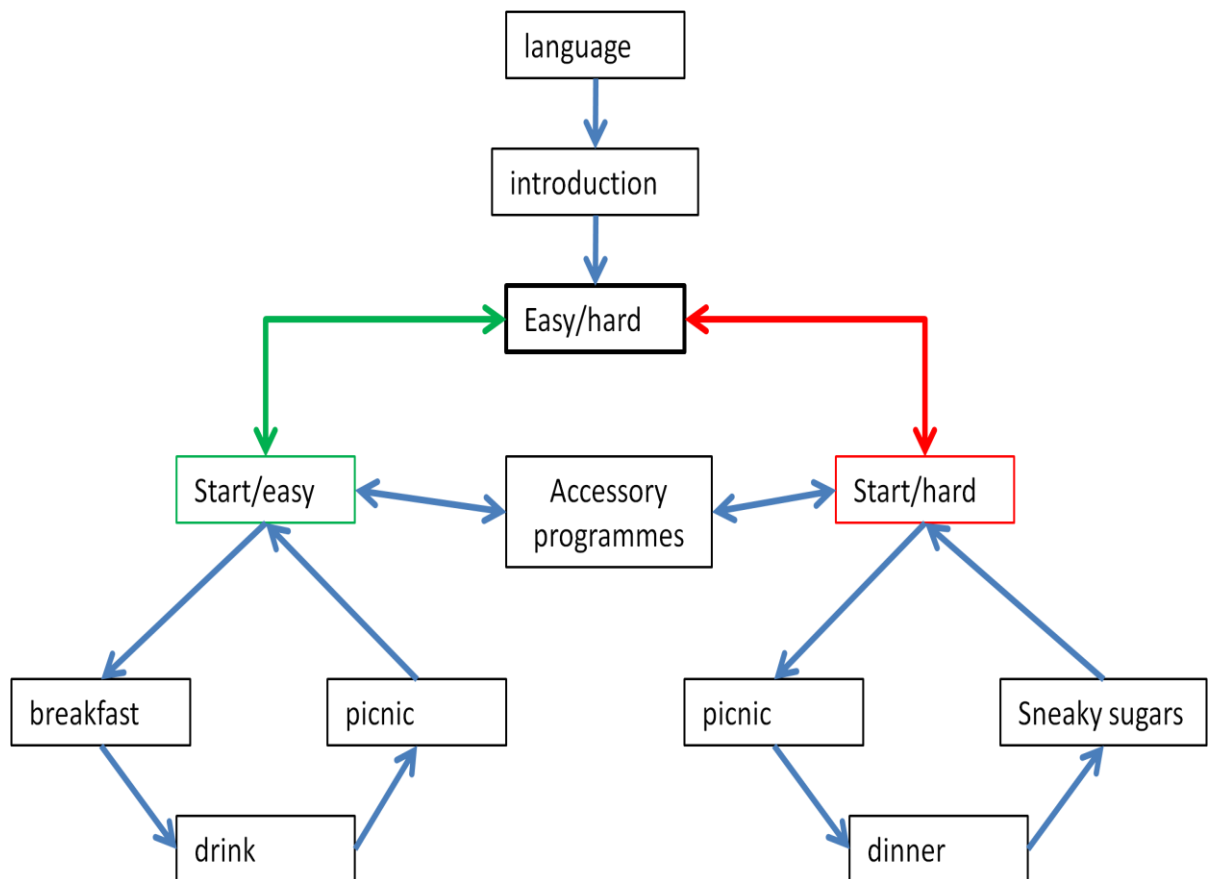
Unfortunately, this proved unreliable and too complex to achieve so it was decided to separate the two completely. This allowed the development of different levels of complexity in the programme and its accessory content and for the exploration of more complex ideas for the older children. The flow chart for the final structure of the programme is shown in Figure 5.3. The screen shots shown in Figure 5.4 depict the actual appearance of the content within the programme relating to *Easy/Hard*.

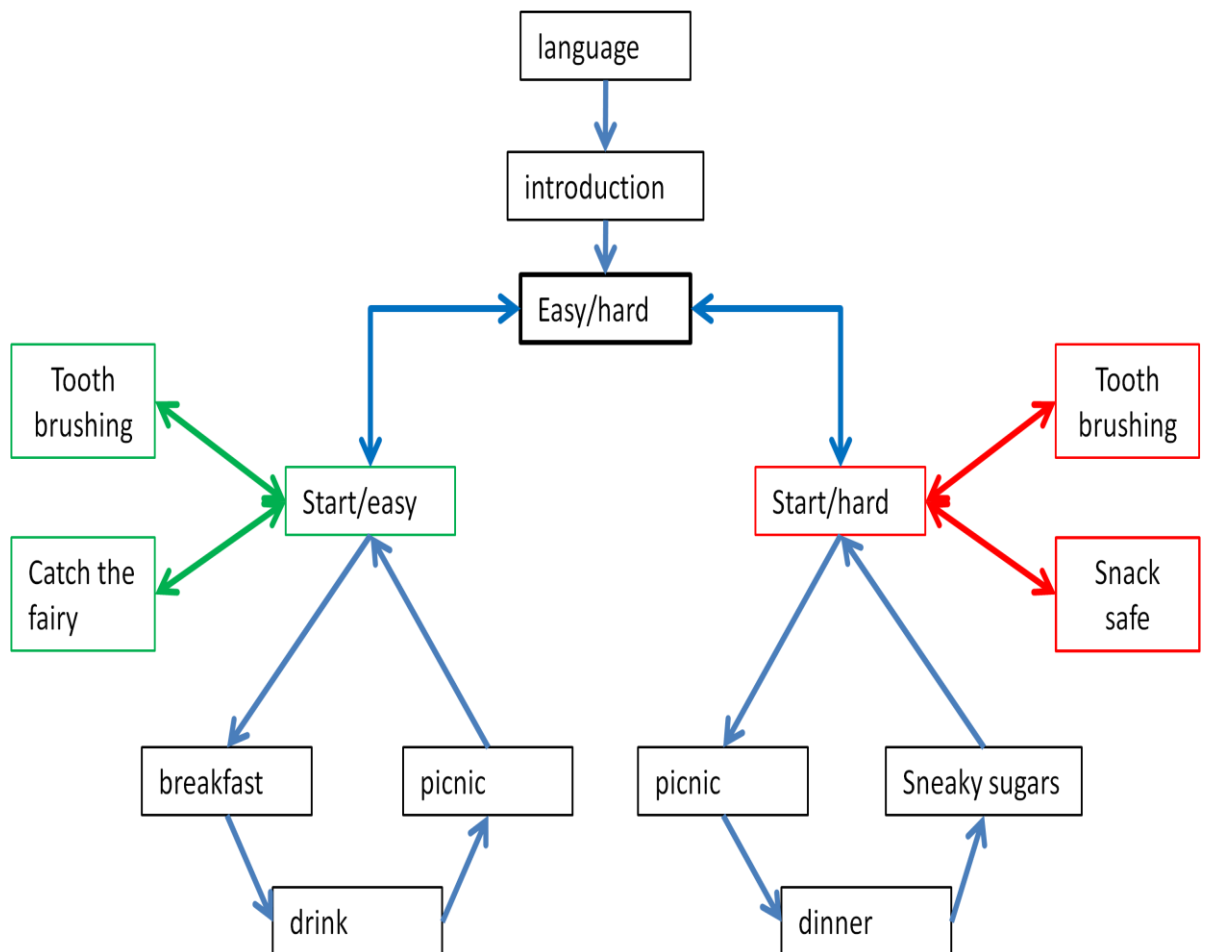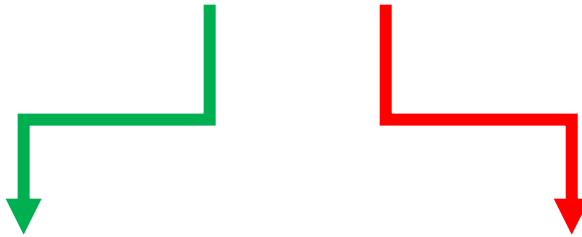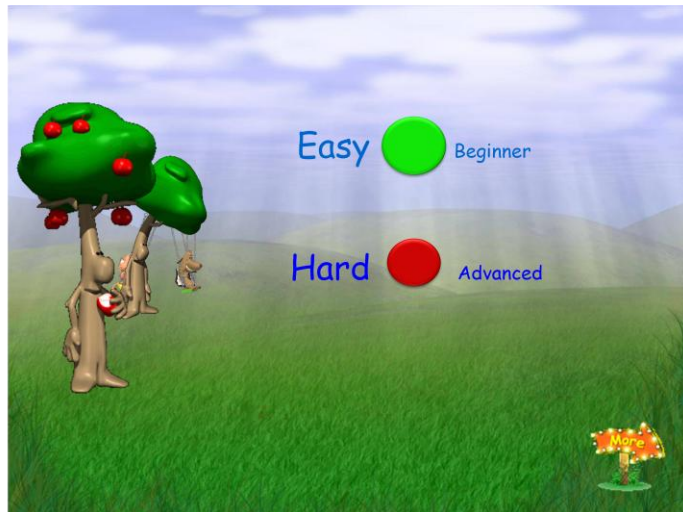Figure 5.3 Flow diagram of finalized programme format.

Figure 5.4 Screen shots representing the branching to Hard/Easy levels.

Easy   Hard

[5.4.2] Interaction alterations

The level of interactive speech for the avatar seemed appropriate and the children were able to navigate the system well. Any increase in the interactive component may have made the programme too easy for the children not stretching them enough.

[5.4.3] Navigation alterations

The 'return to previous' button was also raised two centimeters on all of the slides to reduce the likelihood of accidently clicking on the hidden buttons. Other navigation features were reduced in their incidence as they were not deemed to be essential.

[5.4.4] Script and content alterations

The re-recording of some of the script was required to explain the new format of the programme and the different levels that were now available. Other changes required for the programme included the alteration of several script lines to correct punctuation and spelling.

[5.4.5] Further alterations

Corrections of several slipping links and missing slide transitions were also required. It also seemed inappropriate to have the dog change into a cowboy for a fishing competition with superman, or make one of the food options 'Mark's bogies', tempting as the suggestion was.

The programme was shown to the children again after their alterations were complete. They were satisfied with the new programme and suggested the addition of a 'middle level'. This was taken into consideration for further development.

Chapter 6

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Pilot study

[6.1] Aims

The aims of the pilot study were:

- To assess the method of randomisation and blinding of the sample population.

- To assess programme use and identify errors in the data collection procedure.

- To pilot the assessment tool.

[6.2] Method

[6.2.1] Population randomisation and blinding

[6.2.1.1] Sample population

A small sample of twenty one children were selected, from out with the future main trial area, to take part in the pilot study. The selected school was Sandwick Hill Primary School. This small school was beneficial for several reasons:

a) The class involved had an age range of 4½ -7 years of age.

b) The teacher was familiar with the product and the concept of the programme and happy to be involved with the pilot study.

c) The class intake was from a mixed social area.

Consent was taken for participation from the children's guardians/parents. This was same consent form that was used later for the main trial study (Appendix 4). Every child was given a letter to take home to their parent with an information sheet and the consent forms. The latter were returned to the teacher indicating permission to participate.

[6.2.1.2] Randomisation and blinding

The children were randomly allocated to one of two groups, the intervention or control using randomisation tables. The randomization tables were created in blocks of four to ensure an even spread within groups given that the class numbers were sometimes small.

The first table, (Table 1, (Appendix 5) to be retained by the teacher consisted of a consecutive number series which represented the participant's identification number and the group allocation represented as a (Y) for the intervention group or (N) for the control

group. The names of the consenting children were then listed alphabetically beside the numbers and group allocation. This table was retained by the teacher.

 The second table, (Table 2 (Appendix 6) consisted of the same list of consecutive numbers without the group allocation. This table was to be retained by the experimenter. The teacher filled in the consenting children's names in exactly the same order as on the corresponding table and ensured the names and numbers matched. Thus the anonymity of the subject and their group selection was maintained. The instructions given to the teacher are shown in Appendix 7.

In order for the researcher to remain blind to the group allocation, only the teacher had the key to identity of the study and group participants. This remained the case until the key was broken.

[6.3] Programme use and Data collection

[6.3.1]Programme use and accessibility

The teacher was left with the programme and instructions on its use (Appendix 11). The children in the intervention group were allowed fifteen minute sessions using the programme over the one week period. This was carried out in a separate area of the room set aside for computer activities. The teacher was asked to record any difficulties experienced in providing the time for the children to complete the exercise or any issues that would compromise the study. The control group were provided with a paper based educational booklet at the start of the study this can be seen in Appendix 12.

[6.3.2] Time frame for data collection

The data for the pilot study were collected at two points, the first at base line (Day 1) and then seven days later (Day 7).

[6.3.3] Assessment tool

The assessment tool consisted of 50 questions, the participants (Table 6.1) were asked to identify healthy food images by ticking a box. One mark was given for the correct identification; otherwise the score was zero if no answer was given; and minus one if the answer was incorrect. There were ten images present on each page (Appendix 8).

The children were also asked to draw a picture of the actual playtime snack that they had taken to school that day. The snack was then recorded and given a score, "three" was awarded for a healthy snack; "one" for an unhealthy snack; and "two" for mediocre snack. The scores were then totalled for the separate groups and a mean score was determined.

The baseline assessment scores can be seen in Table 6.2. These scores are very high and would be difficult to improve upon. Therefore, it was essential to increase the complexity of the assessment tool whilst the pilot study was ongoing. Thus the amended assessment tool was used on Day 7.

The amended assessment consisted of 70 questions. Each child was asked to score whether they considered each item to be healthy or unhealthy. Scores were awarded using the same methodology as previously described. The children were allowed fifteen minutes to complete the assessment.

[6.4] Results

[6.4.1] Sample

Twenty one children were recruited (Table 6.1). The class was mixed primary 1, 2 and 3. None of the children had a learning difficulty. There were eleven boys and ten girls (age range four to seven years). The mean age was 5.9 years of age.

Table 6.1 Demographics of the pilot study recruits.

	Intervention group	**controls**
Gender (m:f)	6 girls : 4 boys	4 girls : 7 boys
Mean age (range)	5.8 years	6 years
Number of participants in primary 1	3 girls	2 girl : 2 boys
Number of participants in primary 2	2 girls : 3 boys	2 girls : 2 boys
Number of participants in primary 3	1 girl : 1 boy	3 boys

[6.4.2] Food identification results

The results for the food identification are shown in Table 6.2 below. These include the

results from the amended assessment for Day 7.

Table 6.2 Food identification scores, Base line Day 1 and Day 7 results.

	Intervention	**Control**
Baseline score (Score range, -50 to 50)		
N	N=10	N=11
Mean	42	40.9
Range	38-46	32-46
St Dev	2.981	4.036
Percentage	84	81.8
Day 7 amended assessment (Score range, -68 to 68)		
N	N=10	N=11
Mean	48.7	47.1
Range	40-58	41-56
St Dev	1.86	1.50
Percentage	71.6	69.2

[6.4.3] Recording of actual lunch snack

The recording of healthy snacks as drawn by the children is shown in the Table 6.3 below.

Table 6.3 Percentage of healthy snacks at baseline at one week.

	Intervention N=10	**Control N=11**
Baseline		
Mean	2	2.3
% healthy snacks	40%	54.5%
1 week		
Mean	2.1	2.1
% healthy snacks	40%	45.5%

The mean value for nutritional value lies between min.1 and max.3.

[6.5] Discussion

[6.5.1] Population, randomization, blinding

The randomisation worked well, producing an even gender and age distribution in both groups.

The researcher remained blind to the group allocation throughout. The teacher found the instruction on randomization clear and easy to follow (Appendix 7).

[6.5.2] Programme use and Data collection

Several of the images created difficulty in identification. These were later removed and replaced with more easily recognizable images. The programme itself ran well with only two minor errors recorded. The isolation of the computer area was increased through the placement of a small screen by the teacher reducing the chances of exposure of the control group. The teacher was happy with the time allocated to the programme and the participants found it simple and easy to navigate. The teacher kept a written record of the number of times each child from the intervention group used the programme. In total, after one week, the children were each allowed access to the programme six times for fifteen minutes/time.

[6.5.2.1] Amended assessment tool

The amended assessment tool was successful in reducing the percentage scores of the participants to a level that should allow any improvement from the baseline assessment to become evident, after the intervention with the interactive computer programme.

[6.6] Resultant changes

- No resultant changes would be required for the randomisation and blinding of the future control trial.

- The amended assessment tool was retained for use in the control trial.

Chapter 7

An evaluation of the interactive computer programme to facilitate the identification of healthy foods: A randomized controlled trial.

[7.1] Aims

To evaluate the effectiveness of the interactive computer programme in relation to:

- Teaching children to identify healthy and unhealthy foods.

- Change in the children's actual playtime snacks.

[7.2] Method

[7.2.1] Sample

The sample was drawn from two schools, Stornoway Primary and Laxdale Primary, and consisted of a mixture of both Primary one and Primary two classes. Three classes were involved from Laxdale Primary and four classes were involved from the Stornoway Primary School.

A tutorial for the teachers from each school was given on: (I) the use of the programme, (II) how to deal with any problems and (III) how to conduct the randomisation of the children into study and control groups whilst maintaining research blinding as undertaken in the pilot study.

[7.2.1.1] Power Calculation

The required sample size of 70 subjects was determined to be adequate using a power analysis based on a study carried out in Victoria Nursery School, Lanarkshire in 1998. This used an earlier version of an interactive computer programme and the assessment tool (Roebuck et al. 2000). Using the standard deviation (2.093) as an estimate of the pooled standard deviation (pooled across study and control groups), to be able to detect an improvement of two units (20%) difference in scores in the study group over the control group, with 80% power, at the 5% significance level, 19 children in each group would be required. For 90% power, 25 children per group would be required. We assumed that there would be attrition of approximately 20% and so recruitment of 70 subjects was deemed reasonable. This calculation was prepared in advance of the user group and pilot studies as it was necessary to plan the recruitment well in advance, given the small numbers of children on the Island of Lewis.

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[7.2.2] Ethical approval

Ethical approval for the study was cited by the University of Glasgow (Appendix 9).

Positive written consent was required by the ethical committee for participation within the study. The standardized consent forms are shown in Appendix 3.

[7.2.3] Education department approval

Approval for the trial was attained from the Local Education Department.

[7.2.4] Consent

Once written approval for the control trial had been received (Appendix 10) the consent forms were sent home to the children's parents/guardians along with an explanation of the trial procedures (Appendix 3). A two week period was permitted for the return of the consent forms. After this no further trial participants were accepted. Non-consenting children were permitted to join in with completion of the assessment forms as it was inappropriate to exclude them from the class activity but no data were recorded for them. Children with learning disabilities were also excluded from data collection.

[7.2.5] Randomisation blinding and concealment

Randomisation and blinding of the main control trial were carried out in the same way as the pilot study.

The key to the group allocation of the participants was retained by the class teachers. The researcher (Colm Rice) was blind to the group allocation of the subjects. This remained the case until the concealment was broken after the data analysis. The sealed envelopes that confirmed the group allocation were held by Prof M.T. Hosey until after the data analysis.

[7.2.6] Data collection

The data collected were:

- *The identification of healthy and unhealthy foods*. This was collected using the amended assessment form shown in Appendix 8.

- *The children's actual snack on that day*. This information was collected by getting the children to draw and label their choice of snack for the day on the assessment form.

[7.2.6.1]Data collection time frame

Irrespective of group allocation, there were three data collection time points;

- Base line.

- Three weeks after the interactive computer-based programme.

- Three months after the interactive computer-based programme (to assess the longevity and retention of the acquired knowledge).

[7.2.6.2] Statistical analysis

Regression analysis was used to assess knowledge gain and improvement for each group individually and a two sample student t-Test was used to compare improvement between the two groups at each time point. The actual snack selection was to be reported using descriptive statistics.

[7.3] Results

[7.3.1] Sample demographics

Eighty six children were recruited (Table 7.1). The classes consisted of two Primary two
and two Primary one classes, and three mixed Primary one/two classes. There were forty
five boys (52.3%) and forty one girls (47.7%). The mean age was 5.7, (range 4 to 7 years),
the group demographics are shown in Table 7.1. The participants were allocated to
individual groups as seen in the CONSORT flow chart (Figure 7.1).

Table 7.1 Group Demographics.

	control	**Intervention**
Gender (m:f)	N=41	N=45
Mean age (range)	5.8 (4-6)	5.6 (4-7)
Number of participants in primary 1	N=16	N=19
Number of participants in primary 2	N=25	N=26

Figure 7.1 CONSORT flow chart.
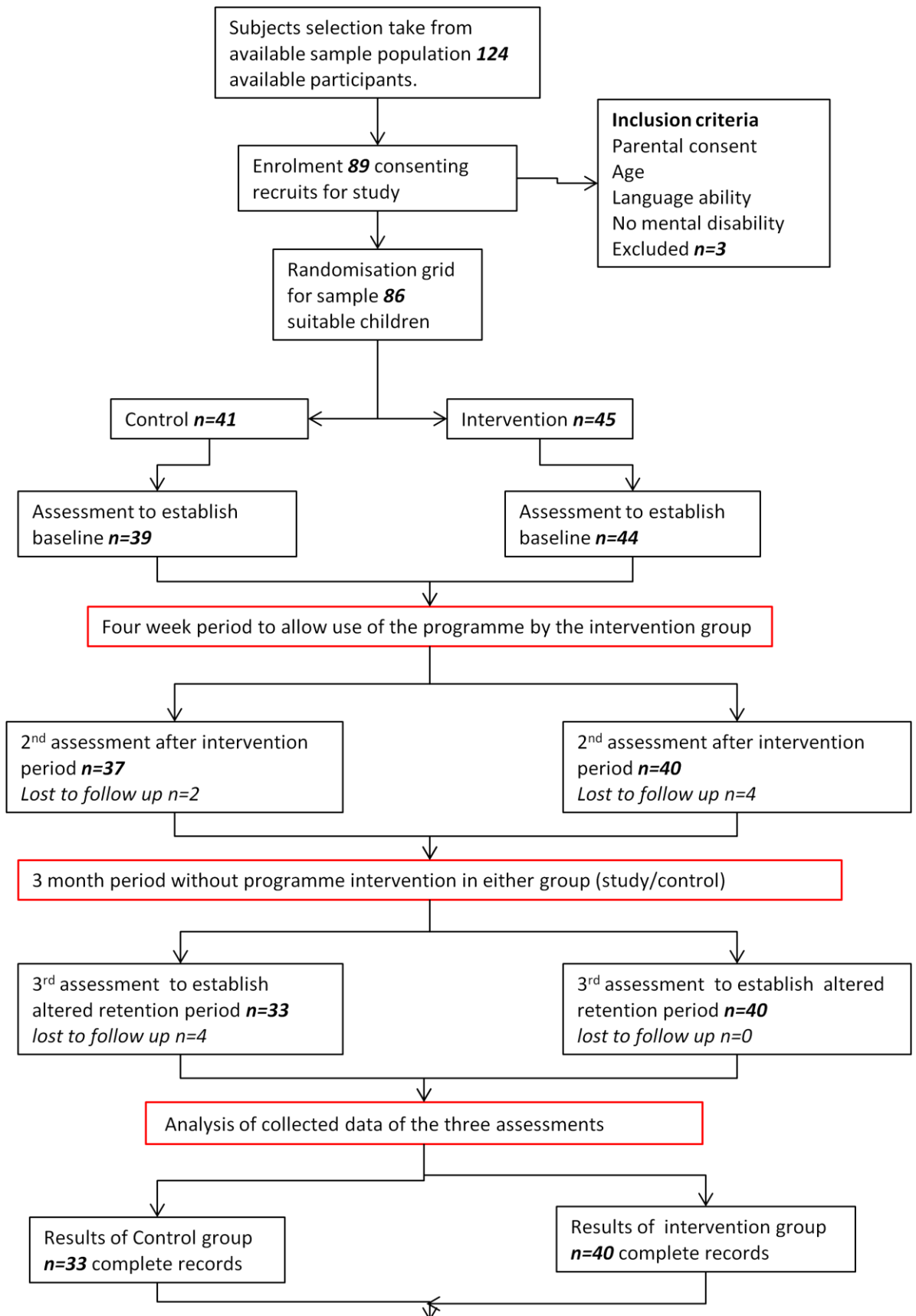
[7.3.2] The results are presented as follows

1) Identification of healthy and unhealthy food stuffs.

2) Testing if use of the programme lead to an improvement in actual choice of snacks.

[7.3.3] Identification of healthy and unhealthy food stuffs

Regression analysis was carried out within the separate groups to determine if there was any significant evidence of improvement over the trial period. The results in relation to the identification of healthy foods are as follows:

*[7.3.3.1] Alterations in healthy food identification within the Control group*

- *Three weeks*

The Control group showed a significant improvement in the scores attained at the three week period compared to the base line assessment [regression analysis P-Value < 0.000]

- *Three months*

The Control group also showed significant improvement in the scores attained at the three month period compared to the base line assessment [regression analysis P-Value = 0.002]. This can be seen in Figure 7.2.

Figure 7.2 Control group scores at; Baseline, three weeks and three months.
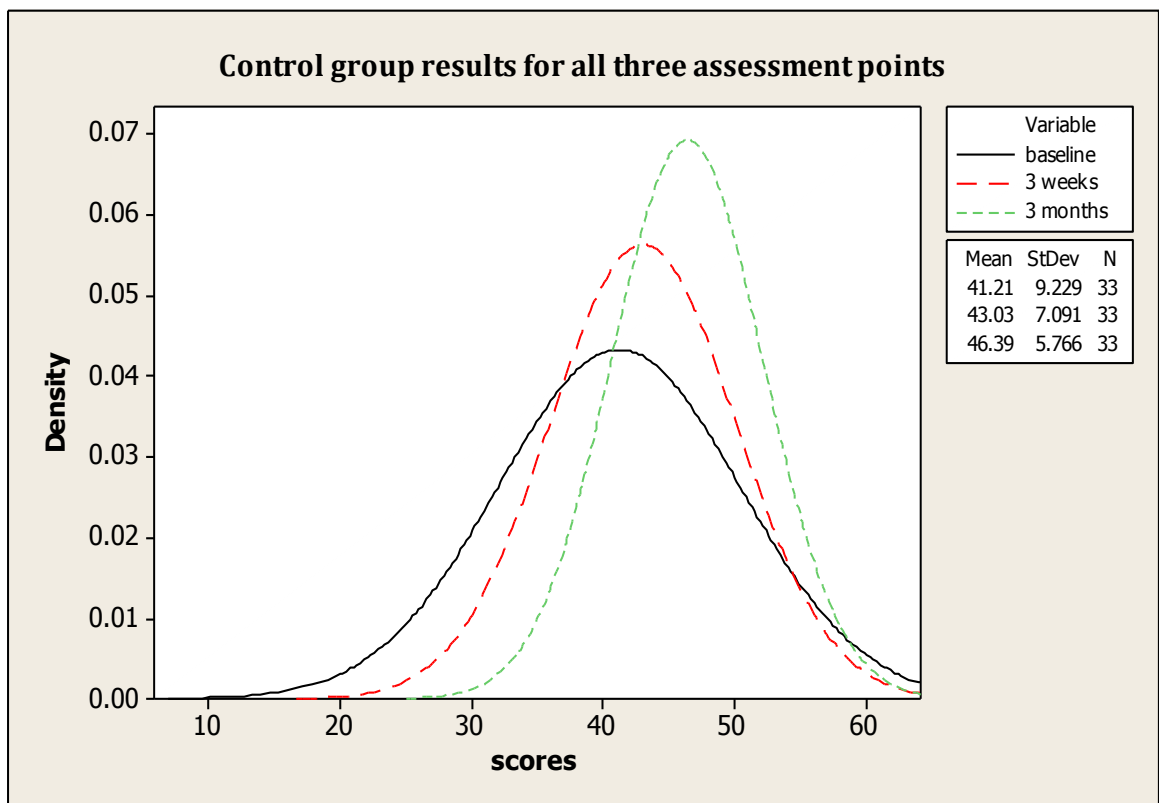
[7.3.3.2] Alterations in healthy food identification within the Intervention group

- *Three weeks*

The Intervention group showed a significant improvement in the scores attained at the three week period compared to the base line assessment [regression analysis P-Value = 0.007].

- *Three months*

The Intervention group showed a significant improvement in the scores attained at the three month period compared to the base line assessment [regression analysis P-Value < 0.000]. This is seen in Figure 7.3.

Figure 7.3 Intervention group scores at; Baseline, three weeks and three months.
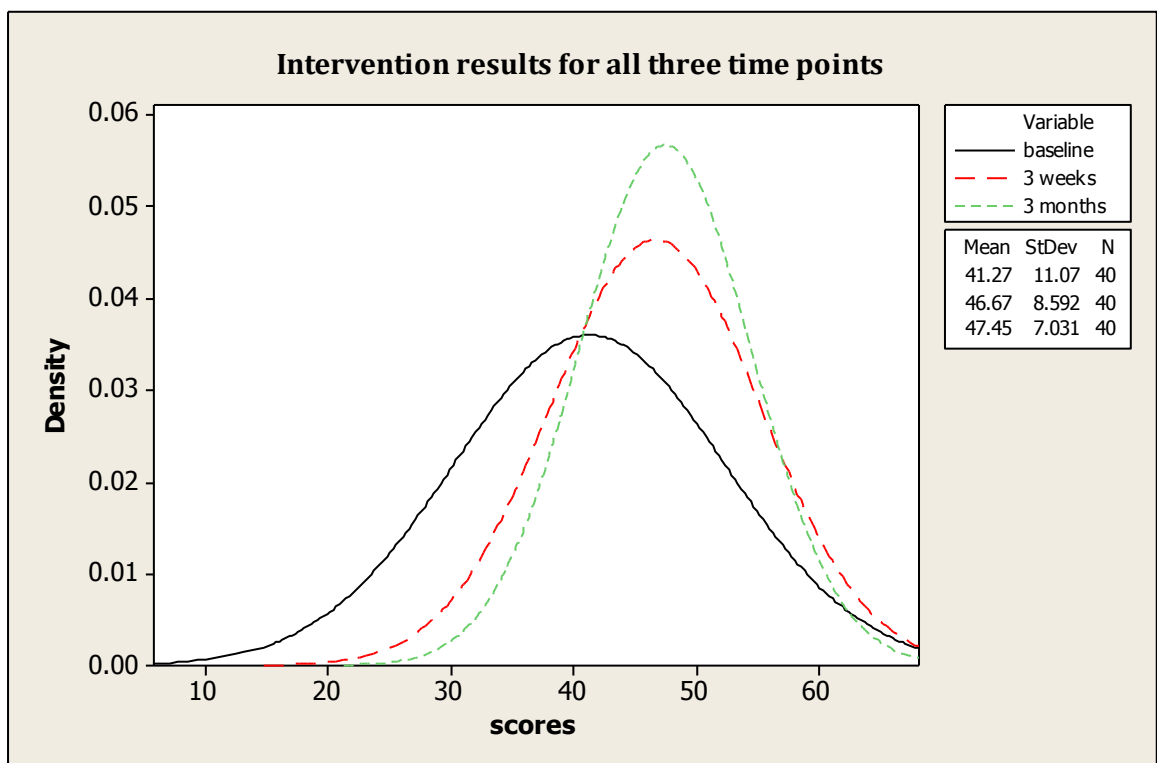
[7.3.4] Comparison between groups in relation to healthy food identification

Two separate t-tests were carried out, the first a comparison between the actual scores of both groups at each time period. The second t-test compared the improvement in scores at each time point. Neither of the two sample standard t-tests conducted showed any significant difference between the two samples at the baseline score, after 3 weeks or at three months.

The first t-test directly compared the score (-68 to 68) at each of the time points. This can be seen in Table 7.2 and represented graphically in Figure 7.4. The second t-test compared the individual's actual change in score over the same time periods this can be seen in Table 7.3.

Table 7.2 T-test results comparing knowledge assessment scores between the groups.

	Control	Intervention	t-Test results for assessment score
Baseline score			
N=	N = 33	N = 40	
Mean	41.21	41.27	P-Value = 0.979
Range	44	50	
St Dev	9.23	11.07	
Percentage	% 60.6	% 60.7	
Three week			
N	N = 33	N = 40	
Mean	43.03	46.67	
Range	32	44	P-Value = 0.055
St Dev	7.09	8.59	
Percentage	% 63.3	% 68.6	
Three month			
N	N = 33	N = 40	
Mean	46.39	47.45	
Range	26	28	P-Value = 0.491
St Dev	5.77	7.03	
Percentage	% 68.2	% 69.8	

Marks are taken out of 68 scores range -68 to +68.

Table 7.3 Results for the *change in score* over the time period in each group.

	Control	Intervention	t-test results for change in score
Baseline score N= Mean Range St Dev	N= 33 Mean Range St Dev	N= 40 Mean Range St Dev	_____
Three week N Mean Range St Dev	N= 33 2.24 36 6.85	N=40 5.5 32 10.7	P-Value = 0.135
Three month N Mean Range St Dev	N= 33 5.18 40 7.99	N=40 6.37 32 8.68	P-Value = 0.547

This graph represents the change in the scores over time, it shows no significant difference in the level of improvement between the groups at three weeks or at three months.

Figure 7.4 Box plot graph shows the actual score at all three assessment points for Control and Intervention groups.

Control and intervention groups at all three assessment times

Control results

Intervention results
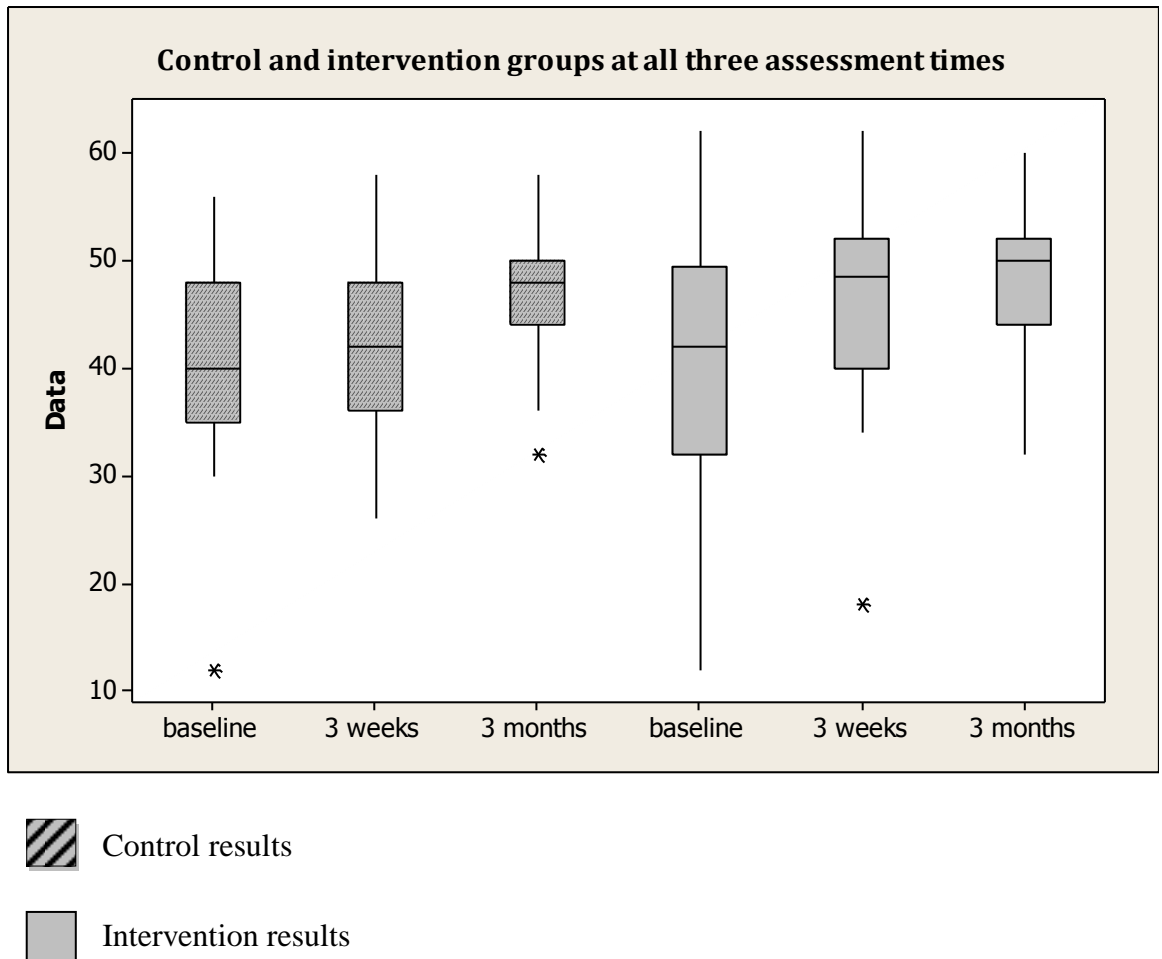
[7.3.5] Recording of actual playtime snack or "play piece"

The actual playtime snack drawn by the children was recorded and tabulated. A healthy
snack was awarded 3 points an unhealthy snack 1 point and a mediocre snack 2 points. The
totals were then calculated for each group. This comparison is shown in Table 7.4. The
number of children who had a healthy snack can be seen summarized in Table 7.5.

Table 7.4 Shows the value attributed to the snacks drawn by the children.

	Control n=33	**Intervention** n=40
Baseline		
N	N= 23	N=32
Mean	2.391	2.344
St Dev	0.722	0.745
Three weeks		
N	N =23	N=32
Mean	2	2
St Dev	0.905	0.762
Three months		
N	N= 23	N=32
Mean	2.348	2.062
St Dev	0.775	0.801

The mean value for nutritional value lies between min.1 and max.3.

Only complete records were used in the calculations (snack recorded at all three
assessment points).

Table 7.5 Summary of results for playtime snack selection.

Number or participants who had a healthy snack	Control	Intervention
Baseline	42.4%	42.5%
3 weeks	30.3%	22.5%
3 months	39.4%	30%

The initial baseline data collected was shown to have been contaminated as free fruit was being supplied to one of the school classes on the day of the assessment. The data for these participants regarding snack selection was discounted for all three assessment points, and not included within the results for playtime snack selection.

[7.4] Summary of results

Regarding the identification of healthy food there was a significant improvement in both the control and intervention groups. However, there was no significant differences between the two groups at either; three weeks or three months.

The recording of the actual playtime snacks, for both the control and intervention groups, showed no significant relationship between the improvements in food identification and actual choice of snack.

Chapter 8

Discussion

[8.1] General Discussion

The interactive computer programme was successful as it significantly improved the children's ability to identify health and unhealthy foods and retain that information, but was not significantly better than the traditional paper based teaching materials.

There are several explanations as to why this should be. It could be related to: the selection of the sample population; the effectiveness of the interactive programme; the performance of the control group; the limitations of the assessment tool; or the design of the study and the possible influence of the Hawthorne effect or contamination of the groups. All of these are possible and may have contributed to a degree to the trial results. The success however of the interactive programme in producing a significant improvement after only a short exposure, supports previously published work with Brown et al (1997), Liberman (2001), Serrano & Anderson (2004), Kreisel et al (2003), Wei (2007) and Campbell et al (2005), who all described a positive effect for the use of interactive computer technologies. This is supported generally by the literature. A review by Lewis, (1999) showed eight of fourteen patient education studies demonstrated an improvement in knowledge utilising interactive computer technology when compared to traditional teaching instruction. These were predominantly in the field of diabetes regulation and asthma control and related to an improved knowledge and clinical outcome. There is a growing body of evidence to support the theory that interactive computer technology is an effective educational tool. There is however a lack of empirical evidence within this age group relating to the efficacy of interactive computer programmes as oral health educational tools.

[8.1.1] Results in relation to other comparative studies

The results within this study support those found by Wei, (2007) and Kreisel et al, (2003) in both these studies the interactive computer programmes were successful in producing a significant improvement in knowledge within the intervention groups. However, both these studies also found a significant increase in the knowledge of the control groups, using traditional paper based teaching methods.

In the present study at the three week assessment point the comparison between the control and intervention group at three weeks was P-value= 0.055 a distinct but non-significant difference and at three months P-value=0.491, this is mirrored in results found by Kreisel et al, (2003) in a similarly constructed controlled trial at assessment points at two weeks and three months respectively and by Wei, (2007) with regard to retention of information one month post exposure.

This is contrary to studies by Liberman (2001), Serrano & Anderson (2004), Wise et al (1986), who showed a significant difference in the improved knowledge of intervention groups using interactive computer programmes compared to control groups. These studies however provided no educational materials for the control groups within their studies. What this provides is evidence that interactive computer technologies can act as effective educational tools but what it doesn't address is how effective they are in comparison to other educational methods.

[8.1.2] The efficacy of traditional paper based education material

Other studies have shown the effectiveness of traditional paper based materials as an effective educational tool in oral health Chapman et al (2006), Vanobbergen et al (2004), Craft et al (1984) and Kay and Locker (1998). In all of these studies there is a general consensus that the provision of traditional paper based materials will produce a significant

short term increase in knowledge or understanding that is retained to varying degrees over an extended time period. In the present study the control group using the traditional paper based materials showed a significant improvement in knowledge at three week and three month assessment points. The percentage increase in knowledge in this study does not appear to be as significant as other studies. This is because the assessment tool used a negative marking format in order to expand the range over which it was effective. When compensated for this would create an improvement comparable to other paper based intervention programmes (Chapman et al 2006, Kreisel et al 2003).

This supports the idea that educational intervention can be effective irrespective of the teaching methodology employed.

[8.2] Control group educational materials

The control group within the present study were provided with a paper based booklet about healthy foods. This was intended to standardise the levels of the control group between the different schools and classes and provide a base standard against which the interactive programme could be compared. However, it is probable the paper based material provided was too effective, not only standardizing the control but educating them.

The traditional paper materials within this study were developed in an interactive format, based on the curriculum targets, of primary one, two and three, for diet and health (Health Education Guidelines, 2000). Therefore, we were standardising the younger children, primary one and two, to a higher educational level than they would normally have attained. This may have falsely elevated the overall standard of the results from the control group.

The control group showed improvements of 7.6% over the study period without compensating for the negative marking system. This was greater than expected and most probably due to the influence of the paper based materials provided. We would have

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expected a rise of 2-4% due to the combination of Hawthorne effect and repeated exposure to the assessment material as seen by Serrano and Anderson, (2004). The increased levels of greater than 10% in some of the controls was unexpected and could be possibly due to a degree of contamination of the control group. Wei, (2007) found similar results and surmised that the individuals sought answers themselves after the initial assessment to improve their knowledge. In the present study it is more likely that classroom conversation, interaction and discussion between the two groups was responsible in part for improvement within the control subjects.

The provision of a simpler paper based booklet might have reduced the significance of its impact. However, in the present study to be able to assess the two groups, the educational materials provided had to be of a high standard and based upon similar pedagogic principles. Inequality in the development of, or provision of, the educational resources provided for either group would bias the overall outcome of the trial favouring one group within the study. Care must be taken to produce pedagogically sound and comparable resource materials in the differing formats required for any trial, to ensure fair comparison between the two groups.

[8.2.1] The effects of Interactivity

Examples of balanced comparative studies can be seen in Rodrigues et al, (2003), Krishna et al, (2003) and Campbell et al, (2005) where the development and quality of materials used was not biased by the delivery format. These studies have shown an increased effectiveness due to interactivity in relation to: education; improved knowledge and reduced clinical symptoms; and anxiety reduction respectively.

Campbell et al, (2005) showed a significant decrease in anxiety levels using interactive computer technologies. The traditional paper based materials, against which this was

compared, were of a high quality but non-interactive in the form of a cartoon strip. Similarly Rodrigues et al, (2003) compared an interactive robot with slide presentations and static model display the latter displaying a relatively low level of interactivity and found the interactive robot significantly better at imparting knowledge. In the trial performed by Krishna et al, (2003) both the control and intervention groups were provided with one and a half hours of vocal information and twenty six written instructions sheets on asthma regulation and control. In addition the intervention group were provided with an interactive asthma education programme (IMPACT). Krishna found that the intervention groups performed significantly better than the control group in knowledge assessment. The control group however did improve significantly in relation to baseline assessment.

Other comparative studies (Serrano and Anderson 2004, Wise et al 1986 and Krishna et al 2003) have employed the use of pamphlets and written information to represent traditional teaching materials, using little or no interactivity, and produced significant results in favour of the use of interactive computer technology. In the present study and that of Kreisel et al, (2003) the control groups were supplied with interactive paper based materials based upon similar learning goals and pedagogic profile to the interactive computer programmes. In both these studies the control groups performed very well reducing the significance of the performance of the intervention groups. Perhaps it is the degree of interactivity and engagement of the participants that is important? This could lead us to the conclusion that it is the quality and interactive nature of the educational material and its pedagogic profile that is effective rather than its format.

[8.3] The range of ability of the participants

The breadth and diversity of abilities within this age group, of four to six years of age, also complicated the study. The age range was chosen because it encompassed Primary one and two children for whom there was little material evidence available where the study was

concerned. It is important during this stage of development that the child should be encouraged to learn and to stretch their abilities (Piaget 1955, Mooney 2002). Children of this age are less independently minded and more likely to be influenced to modify their behaviour and diet (Harbaugh 2007, Roberts et al 2003). A study by Andrews, (2003) also showed children of this age showing awareness of the concepts of; accumulation and consequence, in relation to caries. This makes the sample population important candidates for the trial. The effectiveness of influencing this age group is also important in terms of prevention of early caries and childhood disease.

The breadth of ability in the subjects changed considerably through the year as children rapidly develop a broader skills base, improve their social and intellectual abilities and improve their IT abilities and general knowledge base. The computer programme therefore may have been used with too broad an ability range for the numbers within the study to show any significance difference overall. Future studies could use an intelligence test in the inclusion criteria.

[8.4] Benefit of a blank control group

In the present study the absence of a blank control group limited our ability to assess the actual impact of the Interactive computer programme. On reflection it may have been beneficial if the interactive computer programme was compared to both traditional methods of education and a blank control group.

To compare the improvement of the computer programme against a control group with no exposure to any form of educational oral health material would probably only provide a falsely positive result for the expectations of the Interactive programme since it would not take account of the real life situation. This is reflected in studies by Liberman, (2001) and Serrano and Anderson, (2004) where the control groups were provided with no additional

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material or relied upon material encompassed within the curriculum. In comparison, in studies when the control groups were provided with additional materials in a traditional format they performed much better (Krishna et al 2003, Rubin et al 1986, Kreisel et al 2003). In these studies the difference between the two groups was greatly reduced or not significant. Often this related to a significant increase in the knowledge or understanding of the control group. To fully assess this however, the inclusion of a third blank control group would have benefited this study by establishing the impact of the paper based traditional material.

[8.5] Health Education

These results for the introduction of the basic oral health educational material are similar to those found by Chapman (2006) and Kay and Locker (1998) in that it is possible to increase knowledge through the introduction of a simple teaching programme with high retention of newly acquired information. What we have shown in this study is that the interactive computer programme as a means of providing this simple teaching is as effective as traditional based paper materials. This is in concurrence with other studies (Rodrigues et al 2003, Campbell et al 2005, Casazza and Ciccazzo 2006, Brown 2006, Kreisel et al 2003 and Wei 2007) and in line with current views on oral health education.

The present study differs only in that it is comparing two effective methods of oral health education. The advantages in providing the material in the form of an interactive computer programme are the reliability and reproducibility of the content and the fun and engaging nature of the material, adding to the learning experience. These have been shown to be important factors in retaining younger children's attention and improving their learning outcomes. Liberman (2006) and Krishna et al (2003) showed that children prefer using interactive computer technology for education because it allows them to experiment and

learn through experience and interaction in a way more traditional teaching materials cannot.

Interactive technologies however are not the panacea for all education needs. This study has shown along with Kreisel et al, (2003) and Brown et al, (1997) that traditional methods are still as effective and in some cases more appropriate (Clements and Sarama 2003). It is unclear as yet to how effective interactive technology is and the role it will play in health education. More research is required to present a clearer picture of the efficacy of this technology.

The results from this study and others must also be interpreted in respect to the study's limitations:

- The compliance of the teaching staff involved in the study to adhere to the protocols.
- The participant's access and use of the interactive computer programme.
- Comprehension of the computer content and recognition of the food stuffs.
- Contamination through discussion and interaction of the children out with the classroom.
- The assessment process and collection of data would be subject to the Hawthorne effect or copying.
- Failure to include gender, socio economic status and maternal education as contributing factors in knowledge and understanding.

All these factors are limitations of the present study which may have influence the results and findings of this trial.

[8.6] Limitations of the programme

Establishing a computer programme with different levels for different abilities created several problems. The interactive programme was too extensive, too much of an attempt was made to broaden its appeal over the range of ability of the subjects. This led to the programme becoming too large, indeed the accessory sections made it difficult for the subjects to complete it within the allotted time frame. This reduced the effectiveness of the delivery of the programme core oral health message, by becoming too diverse and less focused.

In the present study there was also no record of how the children progressed through the programme. The teaching staff were encouraged to let the children access the programme at least five to six times during the trial period and this was recorded. However, the progress and ability to navigate within the programme for individual subjects was indeterminable. This may have lead to inaccuracies in the results as some subjects would have greater exposure and therefore be at an unfair advantage. The randomisation of the group might have reduced the impact of this but it cannot be discounted.

The effectiveness of the programme may have been increased with the representation of the avatar character as a child. The increased empathy towards the child avatar may have improved the degree of active engagement with the programme and increased involvement and learning. The programme could be developed to provide both a male and female avatar to avoid sexual bias on the part of the child.

[8.7] Accessory programmes

Even with the increase of computers in the home and their use in schools it could not be assumed that all the children had sufficient skills to navigate through the programme (Strommen and Alexander 1999, Inkpen et al 2001), or adequate computer experience to

understand the concepts. It was reported that some children did utilise the "Catching Fairies" programme routinely to improve their mouse skills. The more advanced children coped well with the more abstract concept in "Snack Safe", which dealt with the ideas of accumulation and consequence. This supports results by Andrews et al, (2003) of the developing social dynamic and understanding that is possible within this age group.

[8.8] Assessment tool

The development of the assessment tool was complicated due to the broad range of intelligence of the children within the study. To overcome this difficulty we created a pictorial based assessment which could be understood by all the children. We decided to use photographic images to represent the food types as children understand and relate better to real images (Talbot et al 1999). It has also been shown that children's memory recognition and recall are improved using photographs rather than drawn images.

The breadth of the children's experiences led to some difficulties in developing the assessment tool, for example the inability to read well and failure to recognize some food stuffs when represented pictorially. Indeed, some children have only even seen sliced carrots and tinned corn; this can make it difficult to represent things outside the experiences of the child. This is reflected in work carried out by Mitra and Rana (2001) whose work with children in India showed their reliance on familiar ideas and objects that they related to the computer functions. At the other end of the spectrum, some children have a well developed understanding of food stuffs being able to make relatively complex nutritional decisions.

The development of an assessment tool that could bridge across such a range of knowledge even in this group is challenging. Fortunately, with the help and assistance of the teaching staff in developing and testing the assessment tool the final modified version performed

adequately within the pilot study, although would benefit from further refinement to improve sensitivity.

It may be that the sensitivity of the assessment tool was insufficient to accurately determine the full extent of any difference between the study and the control group. The original assessment tool (Roebuck et al, 2002) was a simple tool based on the identification of ten images, five healthy and five unhealthy foods. The increased complexity of the interactive computer programme used in this study and the breadth of educational experience of the children, forced an expansion of the assessment tool to 70 questions. Even with this expansion it is difficult to encompass the abilities of the full range of children with in the study, whilst attaining sufficient sensitivity to identifying differences between the two study groups.

The development of a tailored assessment tool that could compensate for this breadth of ability, to more accurately measure improvement, would be advantageous. It would however have to be a very sophisticated assessment tool which would require more refinement than the extent of this study would allow.

[8.9] Playtime snack or "Play piece" selection

We found there was no statistical relationship apparent between the playtime snack selection and the ability of the children to identify healthy and unhealthy foods in either the intervention group or the control group.

The recording of the children's playtime snack or "play piece" for the day, allowed us a better insight into the children's diet as compared to recording lunchbox contents. This was because lots of the children take school dinners and therefore don't bring a packed lunch. Recording the selection of playtime snack allows assessment of the interactive computer programmes ability to mediate behavioural change.

Krishna et al, (2003) and Brown et al, (1997) showed the ability of interactive computer technology to affect behavioural change in children from age seven upward thus providing some empirical evidence that interactive technology is effective in health intervention. Campbell et al, (2005) has shown the positive effectiveness at age five and under in reducing anxiety. There has been little evidence gathered to determine if improved knowledge and understanding within this age group would lead to an alteration or modification in dietary behaviour. Evidence from Ramseier et al, (2007) has shown that short term behavioural modification is possible at this age range in relation to toothbrushing, oral hygiene and hand hygiene. However Kreisel et al, (2003) stated that research into the field of nutritional behaviour modification using interactive computer technology requires further investigation in order to determine it effects. Within this study both the control group and the intervention group should theoretically demonstrate a behavioural change as both are subject to oral health educational materials. The intervention group should show a significantly greater improvement.

The recording of the children's choice of snack was generally successful, although there was some confusion at the initial assessment about what had to be drawn. Some children choosing to draw themselves, playing outside whilst eating crisps or dressed as a fireman eating "minstrels" etc! Despite this the information recorded appears to be accurate. The teachers checked with the children and often assisted by providing the correct spelling on the black board if the child did not have its playtime snack or play piece with them in the class at the time of assessment

Parents being aware that their children's snacks were being recorded may have favoured healthier options at the time of the assessment. This was however not apparent judging by the snack selection generally.

The nutritional value of the average snack was quite poor with only about a third of pupils having a non-cariogenic snack Often the items were high in saturated fat and salt such as crisps and cake bars, and this supports evidence produced by Griffin and Barker (2008), Rogers et al, (2007) and Ruxton and Kirk (1996).

There was no evidence of any behavioural alteration with regard to the snack selection in participants involved in the study despite the improved ability to distinguish between healthy and unhealthy foods. Thus one can assume that it is the parents who are generally responsible for the selection of playtime snack or play piece. This is supported by Roberts et al, (2003) and Robinson (2000) who concluded that control rests mainly with the parents until the children are aged seven. The snack selection may be more closely related to maternal education and socio economic status than to the children's understanding of food stuffs (Ruxton and Kirk 1996, Maliderou et al, 2006). These factors however are not within the bounds of this study. Further investigation of snack selection in relation to these factors would be beneficial to help develop a better understanding of the issues involved.

[8.10] Contamination

During one of the assessment days in the Stornoway Primary school, one of the primary one classes received an item of free fruit provided for every child by the Local Education Board as part of an ongoing "Healthy Eating Programme". The pieces of free fruit are provided twice weekly for the children as a replacement for their play piece or playtime snack, at the time of the morning break. Unfortunately, due to a change in the scheduling of the provision of the fruit, this coincided with one of the assessment days. It was only when the results were collected that it became obvious as all the children had recorded either an apple or banana as their play piece. The contamination of the data affected fifteen children within the study group in one classroom, eight children from the control group and seven children from the intervention group. The data for these children in relation to

"play piece" or playtime snack was disregarded for all three assessment points and not used within the study.

[8.10.1] Contamination between the control and intervention group

Contamination could not be discounted between the control and intervention groups. There could have been a failure of the teaching staff to adhere to the study protocols and restrict use of the programme to only the intervention group although no evidence was apparent or recorded. It is more likely to occur out with the classroom if the programme was discussed by the children during their lunch or break time. This is more likely to have occurred after the second assessment when children who have acquired information through the use of the computer programme would be in a position to correct their peers informing them of the correct answers on the assessment. This may have contributed in part to the improvement of the control group by the third assessment.

[8.11] Future Study

[8.11.1] Subjective Analysis

Any future studies should include further assessment using some form of subjective analysis such as a Likert scale. Wei (2007) used forms of subjective analysis to determine the success of the interactive computer programme used within that study. Adopting a similar structured questionnaire could give an insight into more perceptual elements of the programme such as enjoyment and perceived knowledge gain, willingness to reuse the programme, and the perceived benefits of its use. The study by Wei (2007) raised several anomalies as the perceived benefits of use of the nutritional programme being assessed did not always tie in with the actual knowledge gains measured. In one case the increased knowledge led to an increase in the perceived barriers to behavioural change. Analysis of

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this kind would allow assessment and refinement of the programme, which would enhance its effectiveness. It would also give us an insight into how enjoyable the programme was for the children, which is an important component of learning.

[8.11.2] Comparative study of interactivity

The rich media of the computer programme may be better at tackling difficult concepts than the paper based materials, but may lack in turn the enthusiasm brought by an actual person. A comparative study looking at the effectiveness of the interactive programme in relation to paper based materials and tutor based intervention from Hygienists or Oral Health Educators, would be beneficial to understanding any advantages that may be gained using differing approaches to the delivery of similar materials. This would require the development of materials designed around similar pedagogic principles and designed to attain the same educational goals. This would then allow for variation of content and interactivity which could help determine the most effective educational model. The assessment tool would also be important. Alteration of the questions for each assessment would help reduce the Hawthorne effect and group contamination risks. This would however require careful screening and structured analysis of the assessment tool to ensure consistency and repeatability and would be difficult over a broad ability range.

The importance of interactivity could be further investigated through the use of the avatar system by altering the degree of interactivity within the programme format and the avatar interaction. It would be possible to directly compare an actual person delivering a prepared oral health education message in the classroom and virtually via video conference (VC) to an artificial avatar delivering the same message via an interactive computer programme. If the interactivity is as effective through a virtual medium as suggested by Rodrigues et al, (2003), it would allow teachers to effectively reinforce accurate and consistent information with increased frequency without the need to refer to external sources such as hygienists

and health educators. This increased exposure should help to potentiate the long term effects of oral health education which are at present costly to maintain (Chapman et al, 2006).

[8.11.3] Improvements to the interactive computer programme

The programme itself would benefit from adjustment, presently the content is too diverse, this becomes distracting and reduces its impact. The removal of the accessory programmes should help focus the content. A more compact programme may have proved more successful by directing the learning goals to specific topics thus increasing the degree of repetition and reinforcement. The same may be achieved through extending the trial period to increase exposure, however this would increase the risk of contamination occurring. The interactive nature of the programme would allow for further personalisation of the content. This should enhance the effects of the programme as seen with the personalisation of nutritional advice shown by Brug et al, (1999) and Oenema et al, (2001) which increased the efficacy of the advice and induced greater behavioural motivation to affect change. The inclusion of relatively simple software could allow the programme to create specific vocal responses based on the children's choices or refer to the children by name during the programme if they logged in to identify themselves. This would also permit the children to save their progress through the programme and allow the researcher more accurate analysis of any data by tracking the programme use for each individual.

[8.12] Summary

In summary what this research provides is further information about the use of interactive computer technology in relation to oral health education. What it questions is the comparative effectiveness of this technology in relation to more traditional teaching materials and its impact on nutritional behavioural change. To fully assess the impact of this interactive technology we need to ensure the content and information presented in all the educational formats within future studies are comparable. Only then would it be possible to gauge the influence and effect of this developing medium. In relation to modifying behavioural change the evidence supports the theory that dietary control is retained primarily by the parents at this age, perhaps it is the parents or carers who need the education.

This still however leaves some questions unanswered. Even when computer programmes are successful we are unsure why. There is still no empirical evidence to elucidate the underlying mechanism of why interactive computer technology works. We can surmise that it is because of the use of appropriate pedagogic principles or programme design but there is still little direct evidence to date. Further research in this area is required.

Chapter 9

Conclusion

[9.1] Conclusion:

[9.1.1] Primary conclusion

The Interactive computer programme was no more efficient than traditional paper based materials at facilitating the identification of healthy and unhealthy foods.

[9.1.2] Secondary conclusion

The interactive computer programme showed no ability to alter or modify the children's snack selection.

[9.2] Null hypothesis

The null hypothesis is accepted.

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Abstracts

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Interactive oral health education: - a randomised controlled trial.

C Rice[1], MT Hosey[2] ([1]NES, Western Isles Health Board, University of Glasgow, [2]Kings College, University of London). Abstract and Oral Presentation. 9th *Congress of the European Academy of Paediatric Dentistry*. May 29th - June 1st, 2008. Dubrovnik, Croatia.

Aims. To evaluate the effectiveness of an interactive computer programme in relation to: (1) improvement in identification of healthy foods and (2) increase in proportion of healthy food in snack boxes.

Method. Blind randomised controlled trial of 5 to 6 year olds on the Island of Lewis, Scotland. The study group accessed an interactive computer programme, the controls similar paper materials. (1) Identification data was collected via a 68 question pictorial questionnaire (2) Participants drew the contents of their snack box. This was given a score: '1' for unhealthy; '2' for mediocre; '3' for healthy. Data was collected at 3 time intervals: - baseline, 3 weeks and 3 months.

Results. There were 86 recruits (45 boys/41 girls) mean age 5.7 years. Regarding identification of healthy food, regression analysis showed significant improvement in both groups, but t-tests revealed no significant difference between them: - the groups matched well at baseline [Two- Sample T-test for means, p=0.979 95% CI -4.88, 4.76]; the study group showed greater improvement at 3 weeks but this was not significant [Two- Sample T-test for means, p= 0.135 95% CI -7.56, 1.04]. There was no difference seen at 3 months [Two- Sample T-test for means. P= 0.547, 95% CI -5.12, 2.74]. There was neither an improvement nor a difference between the two groups in snack selection.

Conclusion. The interactive computer package was no more effective at (1) facilitating identification of healthy foods or (2) producing an alteration in snack selection.

Appendices

Appendix 1

Questionnaire on prototype interactive computer programme

Function

Do you feel the length of the programme is appropriate for the age group concerned?

_____

Where you aware of any developmental flaws relating to function within the programme?

_____

Interactivity

Did you feel the use of the Avatar was appropriate?

_____

Did you find any difficulties in understanding the directions provided?

_____

Navigation

Did you have any difficulty in accessing or navigating through the content?

_____

Did you find the navigation features within the programme adequate?

_____

Script and content

Did you feel the content was appropriate for the age group it relates to?

_____

Did you note anything inappropriate within the text or verbal direction provided?

_____

Did you feel the programme conveyed the correct oral health message?

_____

Other Comments

_____

_____

_____

_____

Appendix 2

Open questions relating to the Interactive computer programme.

How do you feel the programme could be improved?

_____

_____

_____

What other feature would you have included in the programme?

_____

_____

_____

Do you think children would enjoy using the programme?

_____

_____

_____

Do you think it could be a useful educational tool?

_____

_____

_____

Information sheet version number 1

Date: March '07

Development of an interactive computer programme to facilitate the provision of oral health education for 4 to 6 year old school children

Your child is being invited to take part in a research study being carried out within chosen schools within the Western Isles. The study is to test a computer programme to help children understand which foods can cause damage to their teeth. The programme will be introduced to the children during class time by their schoolteacher. **The study is to test if computer programme does help children identify healthy and unhealthy foods.**

The study will take place over a 3-month period. At first, every child's knowledge of good and bad foods will be tested using a simple picture quiz. Then <u>half</u> of the children will be allowed to use the interactive computer health education programme twice, under the supervision of their teacher. After this, all of the children will be retested using the picture quiz. A final quiz test will be carried out 3 months later. This will be carried out with the principle researcher present (Colm Rice, a local dentist) as part of his Masters degree.

The half the children who were not allowed to use the programme for the first 3 months will be given access to it after the quiz testing is complete. The programme is designed to act as an additional resource for the teaching staff and not to replace traditional teaching methods, which will continue as normal.

We also plan to ask the children to draw their choice of playtime snack. We will do this twice –(before the study and 3 months later).

The information we hope to gain from this study will allow us to develop more effective and improved educational resources for the schools and nurseries within the Western Isles.

All the information collected will be kept strictly confidential. Your child will be not be able to be identified from the measurements that we collect.

It is up to you to decide whether or not your child takes part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form on behalf of your child and give it to them to return to their schoolteacher within 7 days. If you decide to take part you are still free to withdraw from the study at any time and without giving a reason.
If you require further information please telephone **01851 702548**

Thank you very much for your time and consideration,
Yours faithfully,

Colm Rice

Appendix 4

Centre Number:

Study Number:

CONSENT FORM

Title of Project:

Development of an interactive computer programme to facilitate the provision of oral health education for 4 to 6 year old school children

Name of Researchers: Mr Colm Rice, Dr MT Hosey

Please initial box

1. I confirm that I have read and understand the information sheet dated. January 2007 (version...01) for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my legal rights being affected. ☐

3. I agree to take part in the above study. ☐

_____   _____   _____
Name of subject   *Date*   *Signature*

_____   _____   _____
Name of Person taking consent   *Date*   *Signature*

(if different from researcher)

_____   _____   _____

Researcher   *Date*   *Signature*

Appendix 5

earcher

Teachers name: _____   Date: _____

Form 1:

Class no.	I.D. number	Group allocation	Child's name
1	21	n	
2	22	y	
3	23	y	
4	24	n	
5	25	n	
6	26	y	
7	27	n	
8	28	y	
9	29	n	
10	30	y	
11	31	n	
12	32	y	
13	33	n	
14	34	y	
15	35	n	
16	36	y	
17	37	n	
18	38	y	
19	39	n	
20	40	y	

Group allocation **Y** To use the programme

N Appendix 6 mme

Teachers name: _____ Date: _____

Form 2:

Class no.	I.D. number	Child's name
1	**21**	
2	**22**	
3	**23**	
4	**24**	
5	**25**	
6	**26**	
7	**27**	
8	**28**	
9	**29**	
10	**30**	
11	**31**	
12	**32**	
13	**33**	
14	**34**	
15	**35**	
16	**36**	
17	**37**	
18	**38**	
19	**39**	
20	**40**	

Appendix 7

Instructions for completion of Forms.

In the pack there are 2 forms *(Form 1 and Form 2)*. These are to be completed within the class.

The forms are filled in using **only** the names of the children consenting to take part in the study.

Completion of Form 1;

Form 1, has the children's identification number and the group allocation of the children to use the programme (**Y**) or not to use the programme (**N**) for the trial period. The names of the consenting children only should be filled in on this form in alphabetical order.

Form 1 should be photocopied after completion, a single copy to be kept by the teacher and a single copy to be placed in the envelope provided and sealed.

Completion of Form 2;

Form 2, consists of a list of identification numbers. The names of the consenting children should also be filled in on this list in alphabetical order. The list of names must be identical to those on Form 1 and match the identification numbers for each child on Form 1. Form 2 should be returned along with the sealed envelope but not in it.

Appendix 8   Assessment tool

Help Barney pick all the healthy food in each group

Help Barney pick all the healthy food in each group

Help Barney pick all the healthy food in each group

Help Barney pick all the healthy food in each group

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Help Barney pick all the healthy food in each group

Help Barney pick all the healthy food in each group

Help Barney pick all the healthy food in each group

Can you draw a picture of your play piece in the circle and write what it is?

167
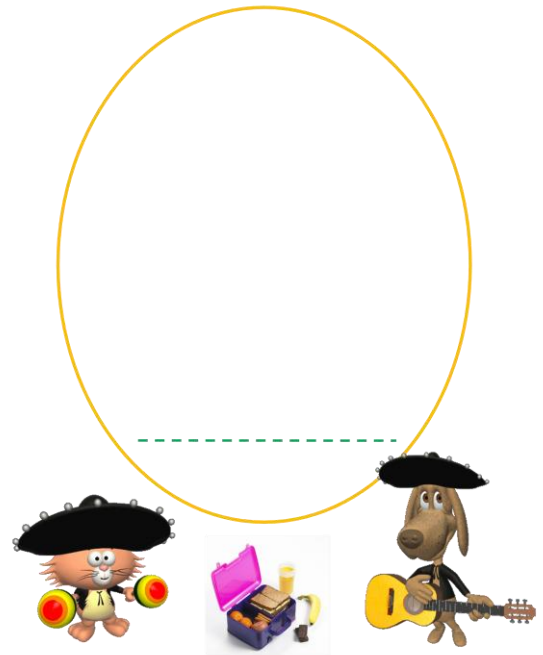
Dr A.M. McNicol

Reader in Pathology

Glasgow Royal Infirmary University NHS Trust

AMMcN/AMJG

Dr Marie Therese Hosey
378 Sauchiehall Street
Glasgow
G2 3JZ

16/08/2009

Dear Dr Hosey

Medical Faculty Ethics Committee

Project Title: ***Development of an interactive computer programme to facilitate the provision of oral health education for 4 to 6 year old children.***
Project No.: ***FM01106***

The Faculty Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study now that the requested revisions have been incorporated. They are happy therefore to approve the project, subject to the following conditions:

- The research should be carried out only on the sites, and/or with the groups defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment, except when it is necessary to change the protocol to eliminate hazard to the subjects or where the change involves only the administrative aspects of the project. The Ethics Committee should be informed of any such changes.
- If the study does not start within three years of the date of this letter, the project should be resubmitted.
- You should submit a short end of study report to the Ethics Committee within 3 months of completion.

Yours sincerely,

Dr. Anne M McNicol
Faculty Ethics Officer

Colm Rice

NHS Dental Clinic

56 Bayhead

Stornoway

Tel. 010851 706461

e-mail colmrice@aol.com

Chairman Children's Services

Comhairle nan Eilean Siar,

Sandwick Road,

Stornoway.

Dear Sir,

I am currently a dentist with the Western Isles Health Board, undertaking a MSc. research degree project with Glasgow University.

I have been working in the Western Isles for 7 years and I am aware of the complexity of issues surrounding the problems with provision of dental care and treatment, which have also impacted on the dental health of the children locally. At present our children's teeth are ranked third worst in terms of decay the Britain. In an attempt to combat this problem nationally the 'Oral Action Plan for Scotland' is introducing for children a daily toothbrushing programme within nurseries and schools and undertaking other measures to try and improve oral health and awareness within the community.

To support the national and local measures being taken, I am in the process of developing an interactive computer programme aimed at 4 to 6 year old children. The aim of the programme is help the children develop a better understanding of healthy and unhealthy food choices with a focus on the recognition of cariogenic foods as being bad for their teeth.

The programme is being designed to allow adaptation for use in a bilingual setting to support both Gaelic and English teaching materials and to act as an additional teaching resource which can be easily adapted to keep up to date with developing curricular materials or to include extra material.

The programme is being developed in conjunction with Glasgow Dental school research department and overseen by Dr Marie Therese Hosey, Senior Lecturer/ Honorary Consultant, Paediatric Dentistry. After the completion of the programme and user group assessment a small pilot study of the programme, involving approximately 70 children, would be required before it could be made available as a teaching resource. I would like to request the council education departments' approval to move forward with the proposed pilot study. Should you wish any further information, please do not hesitate to contact me.

Yours Sincerely,

Colm Rice.

Instructions on the use of "Barney's CD about healthy food."

• After inserting the CD open as a file to view.

• Double click on the icon of Barney's CD

• When the file opens double click on the first icon 1a Barney. This programme will open as a power point and should be run as a slide show.

• To do this click on "slide show" on the menu bar and chose option "view slide show" the programme will then run from the selected slide.

This is only a pilot version of the programme and may have glitches within the running order, if the programme fails simple hit the escape button twice and then restart the slide show from slide 1.

Barney's Big Book about healthy food.

This book belongs to.

Dear Sir/Madam

This booklet has been provided for your child to help improve their knowledge about healthy eating. The booklet is supported using an interactive computer programme which encourages the child to make healthy decisions about their choice of snacks and drinks.

The booklet and the programme display a range of food types which have been graded and assessed by both the dental and dietetic departments within the Western Isles. The foods have been classified using a traffic light system to represent the frequency with which we feel it would be appropriate for your child to eat them. The information is provided as a guide only and is based on the 5 A DAY programme which encourages having 5 portions a day of fruit and veg.

The information a flyers provided with the booklet explain the importance of diet in relation to your child's dental health and their general health and development. In order for you to assist your child in completing the booklet provided we have graded the following foods as;

Red represents foods which we would not recommend, their consumption should be restricted to a minimum as they often contain high levels of sugar, salt and saturated fat.

Sweets and chews, confectionary bars, carbonated or fizzy drinks, deep fried foods and foods with high fat contents such as crisps, pastries and pies.

Orange represents foods which we would recommend only on an occasional basis as they contain levels of sugar, salt or saturated fats that would be unhealthy with frequent consumption.

Desserts and ice-cream, fried foods, processed meat products such as burgers, hotdogs and chicken burgers and chicken nuggets, sauces such as tomato sauce and dipping sauces, processed tinned foods such as baked beans and spaghettis in tomato sauce, some dairy produce with high fat contents like double cream.

Green represents foods which we would consider a healthy option for your child and should make up the bulk of their diet in order to provide them with sufficient vitamins and minerals to help them grow and develop.

All fresh fruit and vegetables, freshly prepared meat or fish dishes (grilled, roasted or steamed), tinned fruit in their own juice not syrup, dairy products such as milk, cheese and natural yogurts, whole grain cereals, breads and nuts, soya products and tofu.

A balanced diet is essential to help in the development of your child it should include elements of the five main food groups these are shown below.

● Fruit and Vegetables,

● Bread, potatoes and cereals,

● Milk and dairy,

● Meat, fish, eggs, beans, pulses and nuts,

● Foods with sugars and fats

At the back of the book are several tear out tooth brushing charts. These are designed to encourage regular daily tooth brushing. Regular brushing with a fluoridated tooth paste is essential for the healthy development of your child's teeth in combination with a healthy diet and restriction of foods high in sugars.

Choosing a healthy picnic for Barney and Kitty
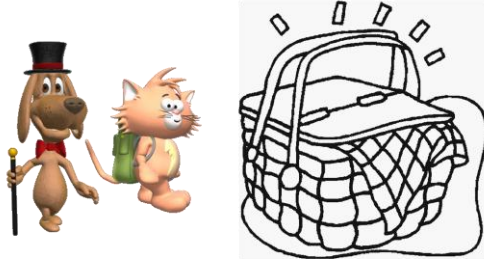
Strawberries must be good for me and sweets would be bad for me

Strawberries are a kind of fruit so that would be a healthy choice for you to eat

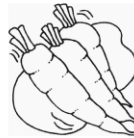Sticky sweets would be bad for your teeth so that would be an unhealthy choice

Help Barney find the healthy foods

Cookies

Carrots

Bananas

Ice-cream

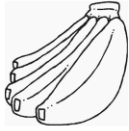## Help Barney find the healthy foods

Toffee apples

Pears
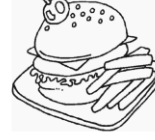
Hamburger

Fruit Juice

Help Barney find the healthy foods

Fizzy Drinks

Milk

Raisins

Apple-pie

Help Barney find the healthy foods

Lollypop
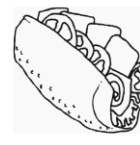
Sandwich

Hotdog

Popcorn

Help Barney find the healthy foods

Cake

Apple

Doughnut

Danish Pastry

Help Barney find the healthy foods
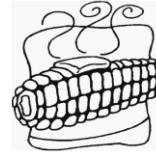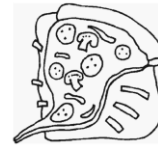
Corn

Pizza

Salad

Sweet lolly

Help Barney find the healthy foods

Asparagus
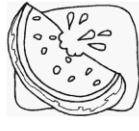
Watermelon

Cheese

Pasta and sauce

Help Barney find the healthy foods

Peas

Chocolates

Fried Chicken drumsticks
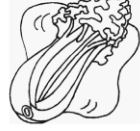
Celery

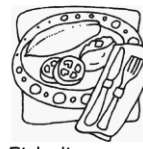## Help Barney find the healthy foods

Baked potato

Blueberries

Cucumber

Eggs
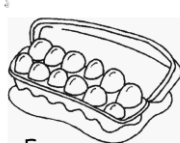
Help Barney find the healthy foods

Strawberries

Ice-cream

Fish dinner

Fried eggs and bacon

Which grow up high? Which grow under the ground?

Which grow up high? Which grow under the ground?

3↓ GRAPES   6➡ PLUM   5↓ APPLE

2➡ ORANGE   1↓ PEAR   4➡ BANANA

Apple   Orange   Cherry   Lychee   Pear
Peach   Kiwi   Figs   Grapes

175

Crossword 1

1 (corn image)
2 (mushrooms image)
8 (carrots image)
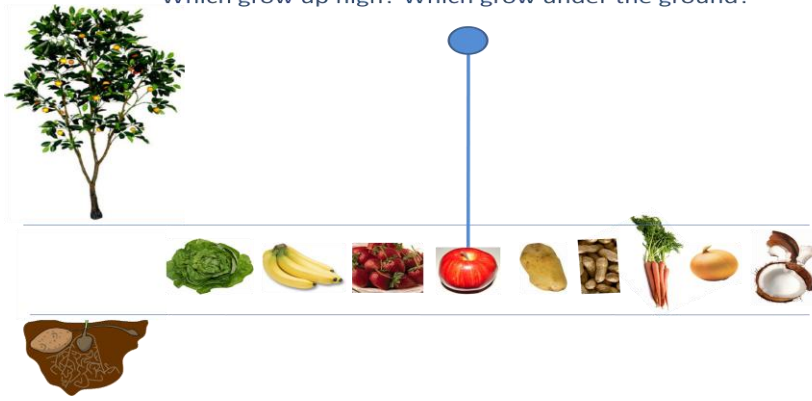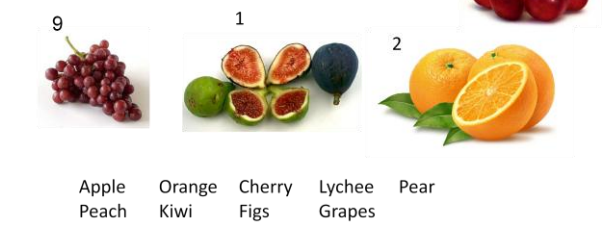
Carrot peppers corn onion peas tomato courgette mushrooms
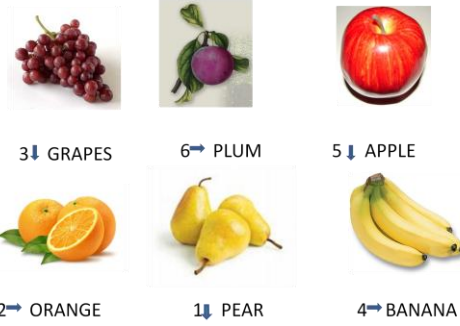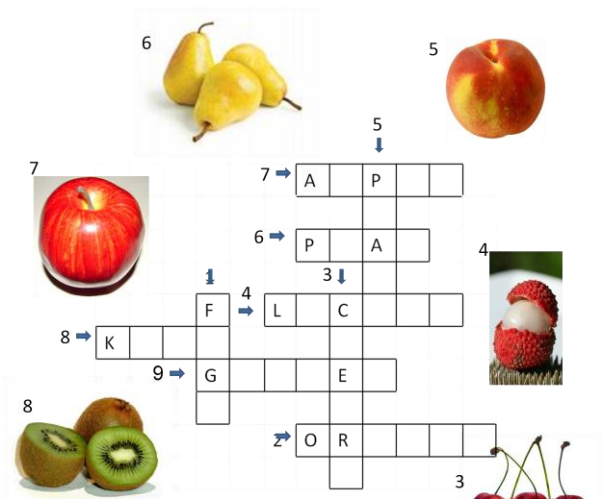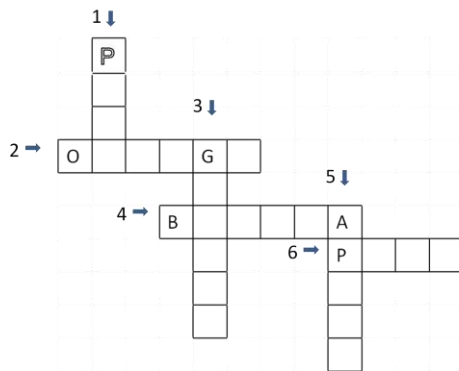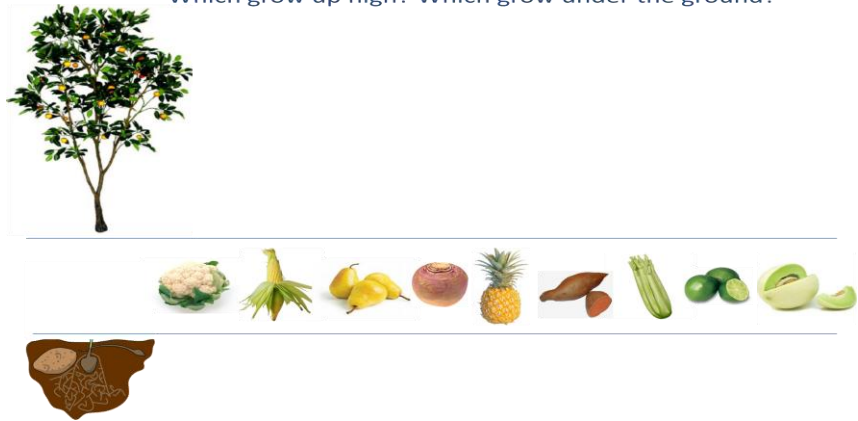
Crossword 2

4 (peas image)
5 (courgette image)
3 (peppers image)
6 (tomato image)
7 (onion image)

1 BEANS   2 CARROT   3 CELERY

4 TOMATO   5 PEAS   6 POTATO

Fill in the fruit name then write it again on the line underneath.   Fill in the vegetable name then write it again on the line underneath.

Avocado   Apple   Lettuce   Carrots

_____   _____   _____   _____

Lemon   Pineapple   Broccoli   Peas

_____   _____   _____   _____

Bananas   Grapes   Cauliflower   Onion

_____   _____   _____   _____

Cherries   Strawberries   Corn   Cucumber
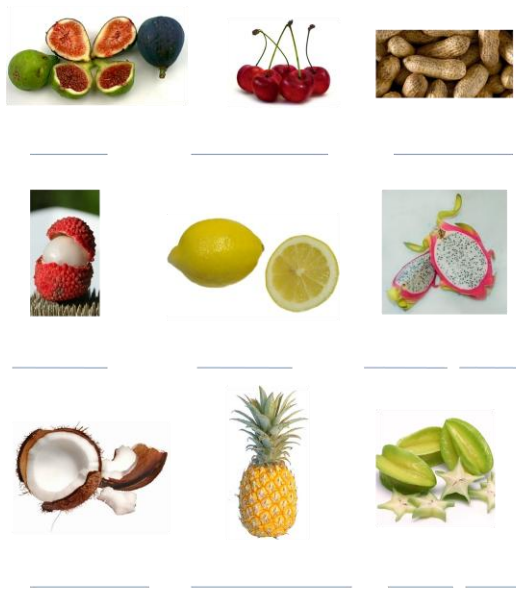
_____   _____   _____   _____

176

Match the fruit with its tree.
Circle the odd one out.

Match the fruit with its tree.

Write under each one what it is.

_anana

_pple

_each

_ater _elon

_iwi

_rapes

Star fruit   figs   pineapple   dragon fruit   coconut
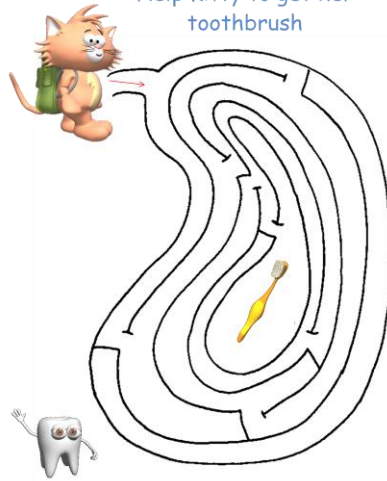lychee   cherries   lemon   peanuts.

Help Barney get to the
Picnic basket and collect
the fruit on the way

Help Kitty to get her
toothbrush

Help Barney find Kitty
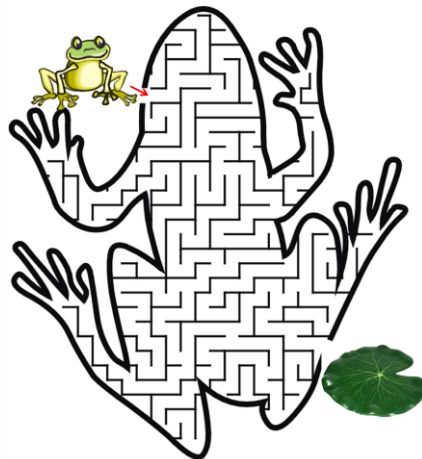
Help Kitty get to
Tommy tooth.
Follow the brushes
and avoid the cakes

Start

Finish

Help Kitty the Cat find her way through
the maze to meet her friend Larry.

Help the frog get to the lily pad.

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Find all the hidden words

M	E	L	O	N	W	S	O	U	P
I	H	S	F	J	R	N	C	P	E
L	U	A	P	P	L	E	A	E	A
K	G	J	I	E	A	F	R	Z	S
Q	U	Z	L	A	E	K	R	O	U
P	L	U	N	C	H	B	O	X	D
Y	D	T	I	H	A	N	T	L	T
V	N	K	D	J	W	A	T	E	R

LUNCHBOX
WATER
MILK
MELON
APPLE
CARROT
PEACH
PEAS
SOUP

Find all the hidden words

J	E	H	E	A	L	T	H	Y	N
O	H	M	P	P	A	U	L	O	D
C	N	E	I	P	L	U	M	O	T
O	L	T	L	L	Y	E	A	U	O
G	R	A	P	E	L	N	N	M	A
R	M	D	O	I	F	I	G	S	G
Y	R	R	E	B	E	S	O	O	G
S	E	B	L	E	S	I	Y	Z	V

HEALTHY
LEMON
GRAPE
GOOSBERRY
FIGS
APPLE
PLUM
DATE
NUT

Some words go backwards and one word goes at an angle.

Find all the hidden words

E	T	T	E	G	R	U	O	C	C
R	E	P	P	E	P	O	T	Y	O
M	U	S	T	W	E	G	A	R	L
O	N	I	O	N	Z	T	T	E	O
B	O	B	R	O	C	C	O	L	I
F	T	U	R	R	P	E	P	E	F
T	O	M	A	T	O	G	I	C	L
S	Y	Q	C	A	B	B	A	G	E

ONION
BROCCOLI
CELERY
POTATO
TOMATO
CARROT
CABBAGE
COURGETTE
PEPPER
CABBAGE

Some words go up and down and some words even go backwards.

Find all the hidden words

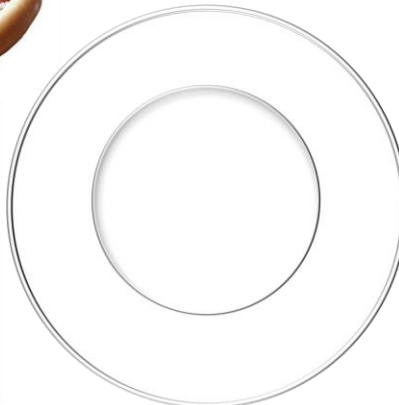| G	T	S	J	V	M	S	G	I	Y
Q	D	E	N	T	I	S	T	P	C
U	E	C	J	O	R	M	J	D	A
K	C	A	N	H	R	I	P	H	V
F	A	R	P	C	O	L	M	R	I
C	Y	B	R	U	R	E	V	B	T
C	A	P	H	E	A	L	T	H	Y
C	H	E	C	K	U	P	Z	L	T

DENTIST
HEALTHY
SMILE
CHECKUP
MIRROR
CAVITY
DECAY
BRACES

179

Circle all the healthy things and draw 4 of them for your lunch.

Draw 4 things to make a healthy balanced dinner.

Choose something healthy for your breakfast.

Draw 3 healthy breakfast things.

Tooth Brushing daily brushing charts

Simply tear out the chart for each month and mark the number of times you brush your teeth each day.

Remember you have to brush your teeth 2 times a day. In the morning after breakfast and last thing at night before bed.

Appendix 13

Barney's CD about healthy food.

Key slides chosen to represent the transition moments within the programme and express the key content features. Twenty nine of the three hundred slides are represented.

1) Start-up slide to allow early differentiation into language groups (facility not utilized, concept only).

2) Introduction of programme and visual avatar guide, vocal description of navigation system.

3) Division into Hard/Easy sections.

4) Easy section, *"A day with Barney"* and two accessory programmes.

5) Help Barney choose a healthy breakfast.

6) Selection of five options for breakfast.

7) Help Barney choose a healthy Picnic.

8) Help Barney choose a healthy drink.

   Accessory programmes for the easy section;

9) Accessory programme "Catch a fairy".

10) Actions slide of "Catch a fairy".

11) Toothbrushing section describes the importance of brushing.

12) Inside John's mouth part of the toothbrushing programme.

13) Options within the *Hard* section of the programme.

14) The three option with the *Hard* section of, *"A day with Barney".*

15) Help Barney chose a healthy Dinner, introduction and explanation of the traffic light selection system.

16) Slide selection for healthy dinner using the traffic light system.

17) Slide selection for healthy dinner using the traffic light system.

18) Help Barney find the Sneaky Sugars, introduction to the section relating to hidden sugars within foods.

19) Slide selection for Sneaky sugars using the traffic light system.

20) Explanation slide showing the actual amounts of sugar within products.

Accessory programmes for the Hard section;

21) Snack safe with Jessica and Sam, introduces the idea of consequences and accumulation in relation to snacking and brushing frequency.

22) Slide selection from "Snack safe with Jessica and Sam", showing brushing at school.

23) Slide selection from "Snack safe with Jessica and Sam", showing inside Sam's mouth

24) Slide selection from "Snack safe with Jessica and Sam", emphasizing the importance of brushing.

25) Slide selection from "Snack safe with Jessica and Sam", relating to the use of fluoride toothpaste.

26) Slide selection from "Snack safe with Jessica and Sam", showing Sam's deteriorating oral hygiene and development of carious lesions.

27) Slide representing the introduction of key words and phrases into the programme "Vitamins".

28) Slide introducing the topic of the "water cycle".

29) End Slide.

1) Start-up slide to allow early differentiation into language groups (facility not utilised, concept only).

2) Introduction of programme and visual avatar guide, vocal description of navigation system.
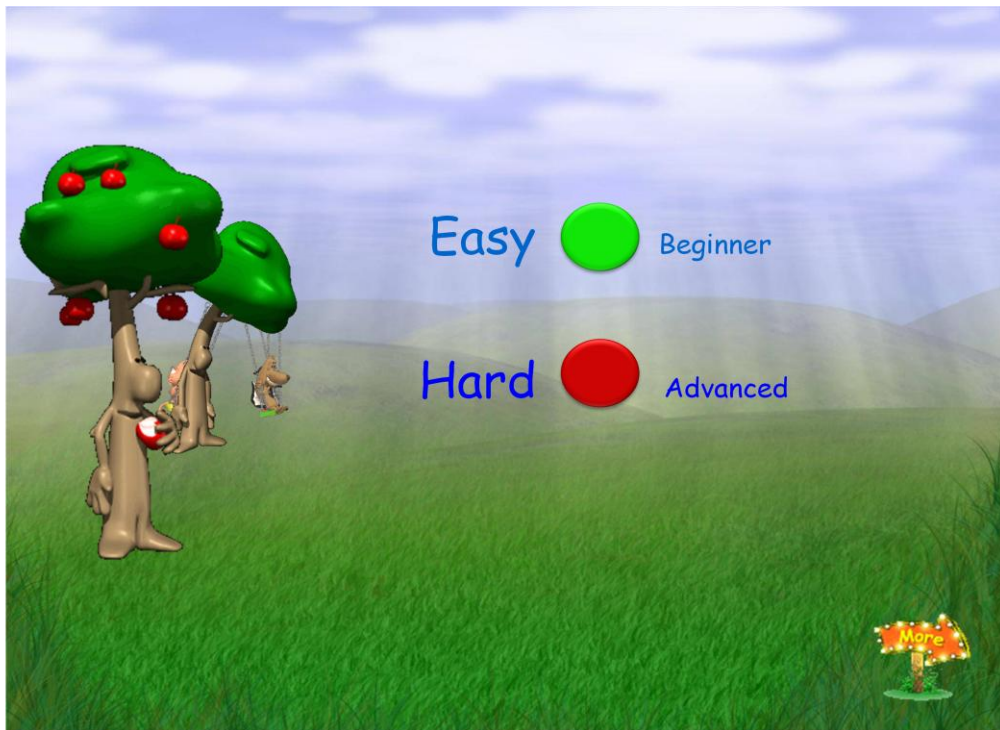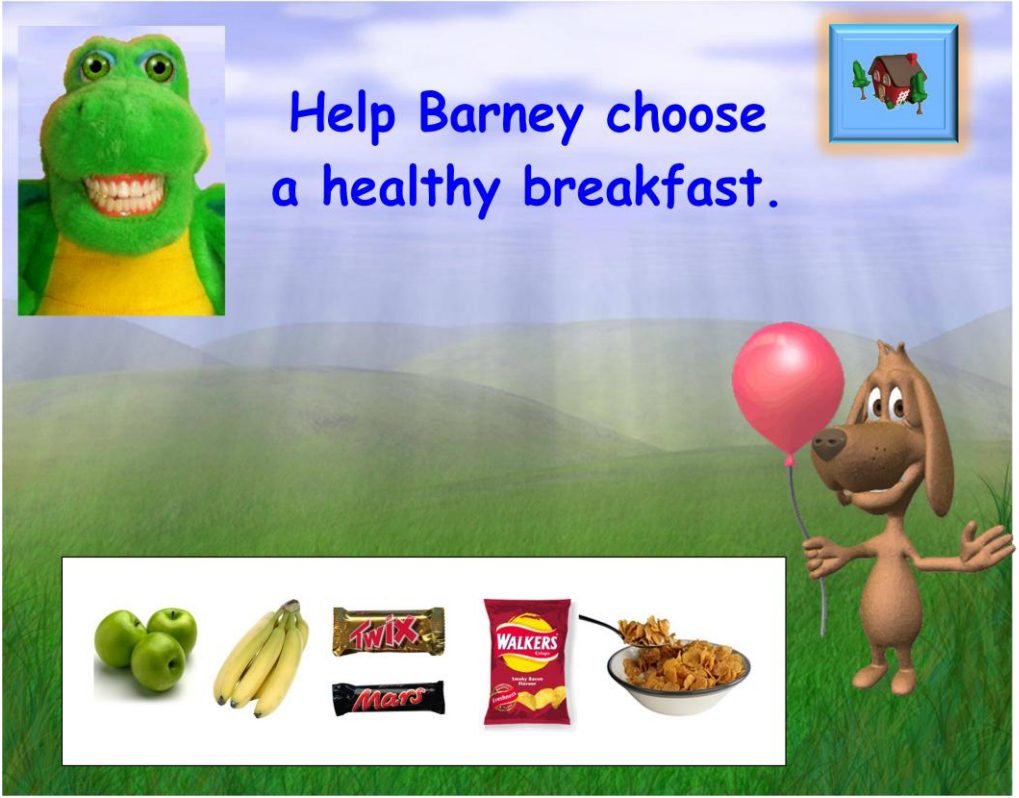
3) Division into Hard/Easy sections.

4) *Easy Section*: "A day with Barney", and two Accessory programmes

5) Help Barney choose a healthy breakfast.

6) Selection of five options for breakfast.

7) Help Barney choose a healthy Picnic.

8) Help Barney choose a healthy drink.

9) Accessory programme "Catch a fairy".

10) Action slide of the "Catch a fairy", programme.

11) Accessory programme "Toothbrushing".

12) "Inside John's mouth" section within the toothbrushing programme.

13) Options within the hard section, "A day with Barney" and two accessory programmes.

14) Options within the hard section of "Help Barney have a healthy day".

15) Slide explaining the traffic light selection system.

16) Slide within the Healthy dinner section.

After you have worked out the right answer for all 3 foods you can click on the arrow to move on.

1   Fish and chips

2   Deep fried fish and chips

3   Fish and rice

17) Slide within the healthy dinner section.

Searching for hidden sneaky sugars.

How much sugar do you thing things have in them?

18) Introduction to the section on hidden sugars.

19) Slide within the Sneaky sugars section.

20) Slide relating to incorrect choice within the Sneaky sugars section of the programme.

Jessica and Sam are just waking up why don't you click on the little picture of teeth to look inside Sam and Jessica's mouths and see what their teeth look like.

21) Introduction to "Snack Safe with Jessica and Sam".

Jessica brushes her teeth after lunch but Sam had another sugary drink and didn't brush his teeth. You can see what is happening inside their mounts by clicking on the pictures of the teeth

22) Jessica and Sam at school.
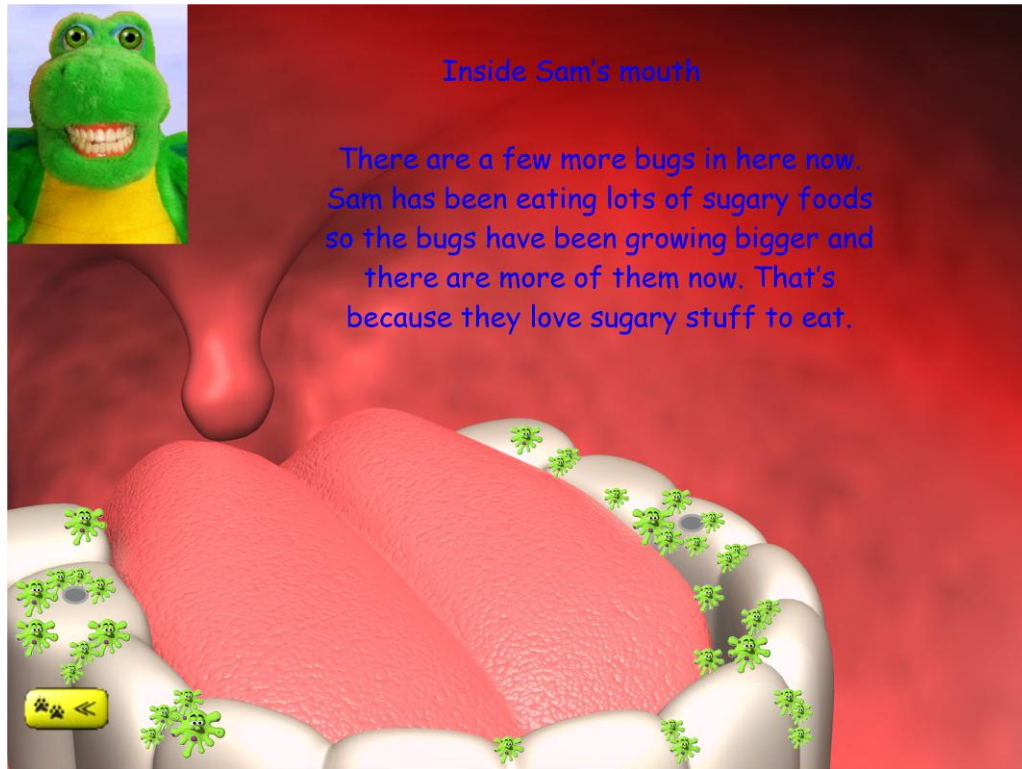
23) Representation of Sam's mouth with bacteria and early carious lesions.

24) Slide from "Snack Safe with Jessica and Sam" emphasizing the importance of brushing.

Inside Jessica's mouth

After Jessica brushes her teeth they all look nice and clean and she has brushed off nearly all the bugs. She has done really wel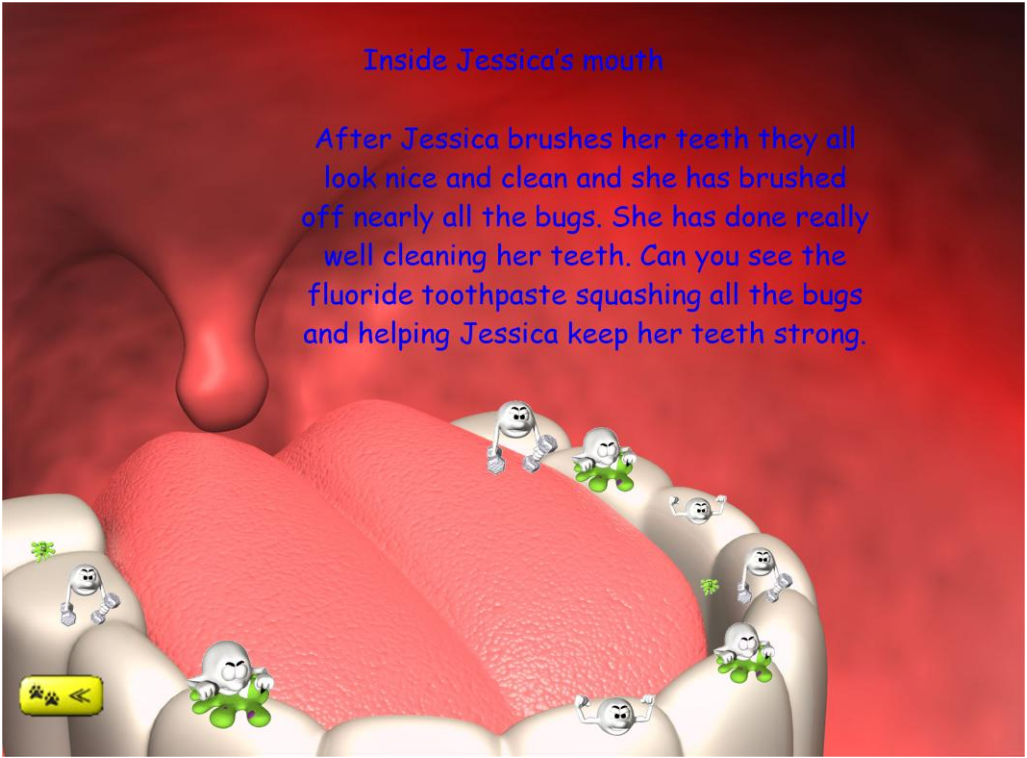l cleaning her teeth. Can you see the fluoride toothpaste squashing all the bugs and helping Jessica keep her teeth strong.

25) Representation of fluoride action within Jessica's mouth.

Inside Sam's mouth

There are a few more bugs in here now. Sam has been eating lots of sugary foods so the bugs have been growing bigger and there are more of them now. That's because they love sugary stuff to eat.

Can you see the holes that are growing in Sam's teeth. That's happened because Sam has eaten too many sugary things and not looked after his teeth.

26) Slide representing the continued rapid deterioration of Sam's oral health.

27) Slide representing the introduction of key words and phrases "Vitamins".

28) Slide introducing the topic of the "water cycle".

That's the end of game now, to return and play another game with Barney click on the yellow button, to go back to the start page click on the blue button.

29) End slide.