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# Enhancing Museum Visits Through Multimedia

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# ENHANCING MUSEUM VISITS THROUGH MULTIMEDIA

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## **ABSTRACT:**

Computers are playing an increasing role in education. They are being used more and more in all areas of the curriculum. In the teaching of history they may be used in a variety of ways. One such way is to use a multimedia program with children, before bringing them on a museum visit, with the aim of enriching their visit and enhancing their appreciation of the artefacts in the museum. A multimedia programme is developed and implemented with a group of 11 to 12 year olds. This implementation is then evaluated by making comparisons between this group and a control group who are both brought on museum visits.

## **1 INTRODUCTION**

In this dissertation I aim to assess the value of using a multimedia package with children, to introduce them to four artefacts in the National Museum, before bringing them on a visit to the museum, to see the four artefacts.

The literature available on **Computers and the Teaching of History** is reviewed. The role of **Museums in the teaching of History** will be then considered. Various initiatives which have been undertaken by museums and galleries, in the area of multimedia, around the world will then be outlined.

The recent opening of the **Collins Barracks** extension to the National Museum affords me the opportunity to review the use being made of computer multimedia presentations in the National Museum itself.

I will then give a brief account of the development of metal craftsmanship in Ireland in the first millennium. Detailed accounts will then be given of the four chosen artefacts. These are **The Ardagh Chalice, The Derrynaflan Chalice, The Tara Brooch** and **The Derrynaflan Paten**.

I will then outline the steps taken by me in the development of the multimedia package, **Treasures in the National Museum**.

The package will be evaluated, with a view to assessing whether or not the children, who use it, will in fact show a greater appreciation of the artefacts in the museum. Finally I propose, on the basis of the evaluation, to make suggestions for further development.

## **2 MULTIMEDIA, HISTORY TEACHING AND MUSEUMS**

Stones( D.S. 1966) emphasises that learning must be considered an ‘active process’. The more one interacts with the information the more likely one is to retain it.

According to Shneiderman (B.S. 1989) interactive multimedia systems have three characteristics ---

- 1) Multiple media types - text, sound, graphics etc.
- 2) Non-Linear environment - multimedia allows pupils to link and present information by association, rather than in the traditional linear format.
- 3) Users as producers - pupils are given access to a large number of multimedia elements to manipulate and incorporate into their projects.

It is important to adopt a rigorous design strategy, which it is hoped ensures a useful product, in the educational sense because -

- 1) it defines activities to be carried out
- 2) it introduces consistency and
- 3) it provides checkpoints.

This also helps to ensure that children are not presented with a confusing mesh of alternatives, which might hide the relevant information from them.

### **The Interface:**

According to Galitz (W.G. 1997) ‘To be truly effective, good screen design requires an understanding of many things. Included are the characteristics of people: how we see, understand and think. It also includes how information must be visually presented to enhance human acceptance and comprehension and how eye and hand movements must flow to minimise the potential for fatigue and injury.’

The interface is the first impression a user has of the product. This may determine the level of motivation that will be displayed to make steady progress through the package. Software products designed to be used by children should avoid involved keyboard input and complex explanatory texts.

A user - friendly colourful interface takes the following into consideration --- Line, Shape, Texture, Colour, Space, Balance and Appearance. A good screen design must reflect the needs and capabilities of its users. Nielsen and Molich’s(W.G.1997) heuristics for an effective interface provides a useful framework:

- Simple and natural dialogue
- Speak the user’s language
- Minimise memory load
- Be consistent --- Design consistency ‘is the cardinal rule of all design activities’(W.G. 1997). It is important because consistency enhances the learning process. One study(R.D.T.R.G. 1983) found that user thinking time nearly doubled when the position of screen elements was varied on a series of menu screens.
- Provide feedback
- Provide clearly marked exits

Other essential characteristics of effective screen design include:

- Choice of appropriate colours --- Colour can evoke emotional responses and it is necessary to recognise the power of colour. While keeping in mind that colour attracts children, the use of too many overwhelms and confuses, thus interfering with the learning process.
- Clustering principle --- This helps the user to acquire a conceptual organisation for facts about the program.
- Reduced Clutter principle --- Recognising the importance of negative space the number of objects displayed on each screen should be limited.

### **Computers and The Teaching of History:**

When considering the teaching of history we must remember that there are three aspects to the definition of history. It can be considered as the past itself, a body of knowledge of past events and a particular method of studying and interpreting the past and constructing meaning from events.

Most 'absorb' the required facts about the past without any real conception of what history is. Historians are viewed as couriers between past and present. Students do not often have the opportunity to explore the third, methodological component of history i.e. constructing meaning and exploring how historical conclusions are made. The highly subjective methodological component of history's definition, the one which brings the subject to fruition and gives it meaning is often the one most neglected in schools. History is often taught as the facts given by the textbook, with little or no room for exploration of things unwritten(E.A.Y.J.M. 1995).

As historians deal with the analysis of evidence to construct reasonable portrayals, accounts and explanations of past events, one should expect history students to delve into the tacit knowledge of history i.e. that which is not actually said. However evidence indicates that students in high schools demonstrated only a basic knowledge of how to read historical texts (both primary and secondary sources) and tended to equate the true portrayal of history with what they found in their textbooks rather than the primary sources(E.A.Y.J.M. 1995).

The Bradley Commission on History in Schools (B.C. 1988) asserted that historical study should reach well beyond the acquisition of useful information. It should provide context for facts and training in critical judgement based upon evidence including original sources.

Computers have become an integral part of everyday life. It is therefore not unreasonable to consider what they have to offer in the area of education and in particular the teaching of history. There appears to be a niche for technology in the teaching of 'historical thinking', including the interpretation of primary sources and other historical data. Thoughtful and creative use of computers in the history classroom may contribute to building a more powerful history curriculum in schools.

According to Ramos and Wheeler (D.R.R.W. 1989) teachers can use computers to support the development of historical thinking by:

- (1) integrating computers into courses with historical content rather than making them the primary set of courses.
- (2) resisting pressure to focus on the methodology and on the computer techniques, but keeping the historical content as the focus.
- (3) being careful to choose data to fit the methodology.

According to Levstik and Pappas(L.L.C.P. 1987) the context in which history is taught, examined and discussed may be crucial in deciding whether students come to understand and engage in history.

‘Increasing a student’s content knowledge is a constant challenge to history teachers. The introduction of the computer into the classroom helps many teachers meet the challenge by providing the necessary materials and technology for better classroom instruction’(D.M.S. 1988).

Information Technology is a valuable tool, which can enhance the process of teaching and learning history, by making possible activities which would otherwise be impracticable, overly time-consuming or unattractive and which give pupils genuine opportunities for insight into the historical process, or the work of the historian.

The historian and the history teacher work in a context of rapid technical development of I.T. facilities. Through the use of CD ROM discs teachers can widen the range of source materials and the quantity of information resources by combining sheer volume with accessibility. This requires the history teacher to employ more sophisticated strategies for the training of pupils in historical thinking.

Information Technology is also an excellent means of helping pupils with learning difficulties, either intellectual, physical or emotional, to make progress. Using the computer is a powerful motivator for pupils who do not enjoy the traditional means of researching and expressing ideas. Their potential for learning thus becomes more obvious. Sound often provides an important dimension which may be used in a range of imaginative ways. It can be used side by side with text to help poor readers.

It is no easy task to produce educational software which has curricular relevance, fosters conceptual awareness, motivates students and satisfies classroom teachers that they have acquired a valuable resource supporting both teaching and learning. According to Munro and Hillis(R.K.M.P.L.M.H. 1996) many attempts to produce such software have failed, leaving teachers sceptical about the value of computers or indeed information technology in education. Educational computer-based resources are now more powerful, more attractive and easier to use. They are also much easier to develop, due to the emergence of flexible authoring tools. These powerful facilities offer the opportunity to create useful software which can include the map, the old photograph, the newspaper page etc. However none of this computer interaction should replace the field trip or the archaeological dig. The value of first hand experience must be recognised and information technology is not seen as a substitute for primary sources or textbooks. It can, however supplement, enhance and illustrate these resources.

## **The Place of Museums in History Teaching:**

It is generally accepted that museums have great potential as places for informal learning as distinct from the structured learning which takes place in the classroom. communicative but also attentive to the visitors' expectations and needs for learning.

We must remember that any learning which takes place in a museum is informal and cannot depend on the strategies used for formal learning in schools. Informal learning is non-linear, self paced, voluntary and exploratory. In schools the primary teaching tool is the teacher, whereas in museums it is the exhibition. The primary learners in museums are unguided visitors, who explore the museum on a voluntary basis in their own time. These differences indicate that approaches which are radically different to those used in schools and other formal settings need to be adopted.

According to Screven(C.G.S. 1986) in any systematic research into what visitors will or will not learn in a museum the following issues need to be addressed --  
(1) The characteristics usually attributed to museum visitors --- They are generally heterogeneous in age, attitudes, interests, skills, motivation, expectations and preconceptions about what they view.

Observations have elicited a number of different categories of visitor behaviours (C.G.S. 1986). They include ---

- a) Those who move quickly through the whole museum, rarely stopping for long at any of the exhibits.
- b) Those who explore at random, looking for something which may interest them. If found they will spend a great deal of time viewing these particular objects.
- c) Scholars, hobbyists or students who go directly to view preselected objects. These generally have a background knowledge, which means they make effective use of the visit.

(2) Attraction and attention --- Attraction can be gauged by counting the number of people who stop to look at an object and attention by the length of time they spend looking at it. Both are important prerequisites to learning anything from an exhibit.

The effectiveness of such features as --- two dimensional versus 3D objects, photos versus real objects, originals versus copies, live versus inanimate, complexity, novelty and size --- as attractors and reinforcers for sustaining attention needs a lot of research. Verbal components are essential to understanding visual information on display. However the reading of text is often in competition with the greater attraction of the non-verbal sensory elements.

(3) Engagement --- What is unique about museums is that they have great potential to engage visitors. Many museums have experimented with various teaching fads that have emerged, but have made little progress in creating a community of museum literates, who can fully capitalise on being in the museum environment i.e. learning as much as possible about the artefacts. Museum literacy is another term meaning museum orientation --- that mechanism which visitors need to successfully process their experience. There is growing support for the view that what visitors experience before museum visits affects their expectations and perceptual and learning sets, which in turn influence the quality and quantity of what is learned during the visit.

Orientation can be physical or conceptual. Much work has been done by museums to develop effective physical orientation strategies but little in the area of ensuring that the visit to the museum is a life enriching experience. This conceptual orientation can take various forms such as --- summary statements, outlines, question headlines, overviews, self administered pretests, films and even self contained interactive exhibits. In providing visitors with orientation help, there are a number of principles to keep in mind(R.L.W. 1986).

Disorientation lessens the potential for quality museum experiences. To avoid disorientation one must be cognisant of the importance of concentration. It is important to remember that distraction lessens concentration and in turn, learning. A moderate level of psychological arousal is necessary however for information to be processed effectively.

Museums should see information as their basic resource, rather than merely displaying objects(S.A. 1991). This implies the need to use a multiplicity of different ways to transfer that information to their visitors. This view does not diminish the importance of the museum artefacts or the fact that they constitute the specialised medium of the museum for the transfer of knowledge. Using hypermedia along with the museum artefacts provides different and complementary routes to knowledge.

Museums and hypermedia share characteristics --- they each are information intensive environments which cannot all be experienced in a single exposure. Each has the means of targeting a number of senses with information, which can lead to information overload. However the human brain is used to processing multimedia information and the variety provided accommodates different learning styles and the different experiences sought by visitors. Use of hypermedia also means that there can be a layering of information. This helps to avoid information overload. This is very important when catering for the diversities among museum visitors.

According to Alsford(S.A. 1991) 'Today's new interactive technologies are not essential to museums'...They 'are trendy today and it is important to resist them becoming ends in their own right. At the end of the day they are only tools to help museums achieve educational goals. But' ..... 'they are relevant tools, compatible with the purpose of museums'.

### **Various Museum Initiatives:**

#### **Electronic Guide To The Museum of Dion (Greece) ---(N.D.D.P.M.Z.Y.V. 1993)**

This is essentially a 'Point of Information' guide to the museum. It allows the user to get a 'plan' view of each floor of the museum. Then the user may select an item location which when selected introduces him to a database of the items. The user can also find out the location of the item within the archaeological site of Dion itself.

#### **The Yugtarvik Museum Project (Alaska) ---(B.S.D.S. 1990)**

The aim of this project was linked to the development of distance education initiatives in Alaska. The Bethel Yugtarvik Museum was chosen as a culturally appropriate focus for the program. The museum is housed in a log cabin chock-a-block with artefacts. Visitors seemed to get less than optimum value from their visits

to the museum. Hyper Card was used to present information about the museum, including information on the Eskimo culture.

#### **The Brancusi Project ---(J.R. 1993)**

The idea behind this project was to bring together international sources to develop an interactive multimedia product based on the works of Brancusi. Its aim was to provide visitors with a quality experience when viewing his work. It allows the visitor to learn about his work, his life and influences. It includes a database of his sculptures, with the facility to 'walk around' some key items.

#### **The Museum of Antiquities (England)---(www 4)**

The museum, run by the University of Newcastle, is a museum of archaeology and specialises in the history of the region i.e. north east England. In June 1997 they opened a virtual gallery which distributes information on the world wide web. The web site allows users to access information on various objects in the museum's collection and offers information to visitors and potential visitors to the actual museum.

#### **The Museum Education Consortium's Interactive Video Project (U.S.A.)---(K.W. 1991)**

This was a collaborative effort by the education departments in seven American art museums. The prototype '**The Museum Visitor's Prototype (1988-1991)**' was developed as part of this research. It is an interactive multimedia prototype developed for use by adult visitors, as a discovery-based learning experience. It was aimed at those with little or no knowledge of art history or art. Its aims included introducing new tools for looking at and learning about art, using video technology to facilitate this. It also aimed to foster a curiosity within the user and so encourage self directed exploration. Thirdly it aimed to offer easy access to a rich multimedia information base of images, films, narrative and text so that the user would have an increased understanding of the artist and his work.

#### **The Palenque Project ---(K.W.T.W. 1990)**

This Digital Video Interactive multimedia application was developed at Bank Street College in New York. The museum product which was developed in 1990-'91 was based on the findings of two previous Palenque products. It allows the user to explore an ancient Maya site and access a multimedia database called '**The Palenque Museum**'.

#### **The Smithsonian Museum Project ---(J.H. 1991)**

This project took the form of a Compact Disc - Interactive called '**Treasures of The Smithsonian**'. This differed from what would be called an orientation program in so far as it did not give information on where items were located within the museum, which in fact comprises 14 museums, nor was it installed in the museum. It was put on sale in the museum to be viewed at home. An audio-visual presentation, featuring images and commentary, with sound effects, was developed around 150 items selected from the museum. There were extra features included with some objects, such as a 'walk around' a sculpture or an opportunity to 'play' a musical instrument.

### **National Museum of Ireland - Collins Barracks:**

In this newly opened section of the National Museum of Ireland there is widespread use of Information Technology to support the exhibits. Different types of presentations are used ---

- (1) An interactive multimedia presentation on one particular item - Cloyne Harp.
- (2) A multimedia presentation on a Historical Character - Daniel O'Connell.
- (3) The silver exhibition is also accompanied by an interactive facility. One is presented again with a menu of topics including hallmarks, guilds, techniques and exhibits. Depending on which is selected various presentations are made e.g. 'techniques' leads to another menu from which one can view examples of a technique along with a textual explanation, while 'hallmarks' displays a video clip.
- (4) In the 'Out of Storage' section, which comprises glass cabinets packed with a huge assortment of artefacts. None of these are labelled (perhaps due to an industrial dispute) so one is totally dependent on a series of computers which have a 'catalogue' or database installed. These computers prove to be rather slow and not very user friendly. Visitors quickly lose interest because of the delay and the fact that queues form, pressurising visitors to move on fairly promptly.
- (5) Another facility provided, which is still under development, is access to the web pages of other museums --- Victoria and Albert, Smithsonian, Louvre, Metropolitan.

The main problem encountered was in the Collins Barracks facility was the difficulty of trying to learn in a distracting environment.

### **Museum Artefacts:**

Even before the Hallstatt Celtic influences were felt in Ireland around the 7th century B.C. a Bronze Age culture, known as the Dowris phase, flourished. However, with the first Celtic invasion, which it is believed came via southern Britain, new insular versions of continental objects appeared, such as swords and penannular bracelets. The Classical Art of southern Europe had begun to influence the work of the craftworkers in central and western Europe but they adopted the vegetable and foliage designs rather than the naturalistic Greek art (E.P.K. 1993).

Around the 5th and 4th centuries B.C. the La Tene Celts began to move west across Europe. A new art style developed which was one of the great achievements of Celtic civilisation. This style arrived in Ireland in the 3rd century B.C. (E.P.K. 1993).

Ireland converted to Christianity in the 5th century A.D. Ornamentation of work became much more sophisticated during the 6th and 7th centuries. With the missionary expeditions of Irish monks from the 6th century onwards Ultimate La Tene art was returned to its homeland in continental Europe through the medium of manuscripts and metalwork (M.R. 1993). Metalworking, manuscript illumination and sculpture developed in parallel.

### **Techniques and Ornamentation Used:**

Smaller items were generally cast in bronze, using clay moulds whereas larger complicated items were produced using the 'lost wax' method. **Casting** of decoration was also used in many workshops in preference to **engraving**. **Die stamping** of thin sheets of silver, gold or copper was often used to copy patterns. **Gilding** of bronze

and silver was often used. **Gold filigree** decorated many of the finest pieces produced. Different effects could be achieved by varying the type of wire used or combining different types. **Granules** of gold were also used for emphasising details (A.T.L. 1983). The colourful style of objects was greatly enhanced by **enamelling**. A technique known as **trichinopoly** was also used in ornamentation (M.R. 1993).

**Millefiori glass** was also used to enhance colour greatly. **Amber**, which had to be imported was used extensively from about the 7th century. **Rock crystal** which, it has been suggested, was recycled from foreign objects decorated many objects (M.R. 1993). Polychrome studs of **cast glass** adorned many of the metal objects.

According to Ryan (M.R. 1993) metalworkers liked to produce items which were large and complex by combining components which were easily replicated.

### **The Ardagh Chalice:**

The 8th century A.D. saw the production of artefacts, on which the skill and technical expertise of the metalworkers is displayed at its best. The Ardagh Chalice, which was found in 1865 near the village of Ardagh, Co. Limerick, is considered to be the finest piece of metalwork of the Golden Age (M.R. 1985). It would have been used as a ministerial chalice for the distribution of the eucharistic wine to the congregation (M.R. 1985). The chalice comprises three main pieces --- the bowl, the stem and the foot --- which are held together by a stout copper bolt, the head of which can be seen in the bottom of the bowl. However the chalice is made up of over 250 components, the combination of which ensured a monument to the unparalleled skill and sense of design of the craftsman or perhaps more correctly, the artist.

The production of such a chalice would have been carried out in three stages. The **first stage** involved the gathering together of all the materials and the preparation of them for use. The materials used in the chalice included gold, silver, bronze, copper, tin, glass, amber, enamel, rock crystal and malachite. As the precious metals and amber were not available locally they would have been imported or recycled from imported objects. The **second stage** involved manufacturing the basic components. The **third** and most time consuming stage of the production involved the actual construction and decoration of the chalice. Once the bowl, stem and foot were assembled decoration could begin. There are several different types of ornamentation used on the chalice, the main materials used being gold, gilt-bronze, silver and glass.

This piece of metalwork is considered to be 'a masterpiece of the technology of its time' (A.T.L. 1973).

### **The Tara Brooch:**

From the number of ring brooches which survive it would appear that they were widely used, if not purely for adornment, then for fastening the large woollen cloaks which were worn, by both men and women, as outer garments. A simple type, which consisted of a penannular ring, the ends of which were slightly expanded and decorated, was introduced from the Roman world in the 1st. century A.D. (A.T.L. 1973).

The pseudo-penannular silver-gilt brooch, found on the beach in Bettystown, Co. Meath, appears to be the most dazzling of the surviving brooches. The fact that it is known as the 'Tara Brooch' may be attributed to the splendour of its ornamentation, implying that it must have had some connection with the royalty of Tara.

It is made of cast silver and comprises a large ring divided into panels by cast mouldings. Every surface of the brooch is decorated. The front is adorned with panels of simple interlace of gold filigree and cast animal ornamentation. Various shapes of amber, i.e. circular, oval and key stone, fill almost all the settings. On one side where the large pseudo-terminals join the rest of the ring an animal head protrudes to attach to a 'hinged tab decorated with four beast-heads in profile' (R.I.A. 1983), which in turn attaches to another animal head at the top of a chain of knitted silver wire. Although there is not much glass ornament in evidence elsewhere, the hinged tab has two tiny human heads in cast glass.

The back of the brooch is better preserved than the front, having all of its panels intact. There is no filigree on the back, the decoration comprising mainly cast imitation kerbschnitt and two panels of silver overlay on copper in Ultimate La Tene style. Confining the filigree decoration to the front of the brooch and using the more robust decoration on the reverse side seem to have had a sound practical reason. The delicate gold wires would have been more easily damaged by the fibres of the cloth on which it was worn (R.I.A. 1973).

### **The Derrynaflan Chalice:**

This chalice, another example of a ministerial chalice, was found on farmland in Derrynaflan, Co. Tipperary in 1980. It is of similar construction to the Ardagh Chalice but there are also important differences. The decoration on the Ardagh Chalice is much more colourful. It is also more lavishly decorated. The Derrynaflan Chalice contains more filigree ornamentation, but the panels on the Ardagh Chalice are more refined. The intrinsic value of the materials used to decorate the Derrynaflan Chalice was greater. It would seem that the Derrynaflan Chalice depends on the value of these materials used rather than on the decorative techniques for its appeal. However in one important respect the Derrynaflan Chalice must be considered to be an improvement of the Ardagh Chalice. The major components of the Ardagh Chalice were not fitted securely together as the central bolt narrowed at the lower end the ring inside the foot did not fit snugly against the stem. Lead was inserted in the stem to correct the problem. The Derrynaflan Chalice, on the other hand, has a hollow stem which fits as tightly now as when constructed. This would confirm that problems with construction had been mastered before the Derrynaflan Chalice was made and thus a later date of manufacture can be placed on it (M.R. 1985).

### **The Derrynaflan Paten:**

The Derrynaflan Paten is an elaborate construction of over 300 pieces. The large shallow dish is made of beaten silver. It is trimmed with two rounds of silver wire mesh between which is a ring of gold filigree panels. Each pair of panels is contained within a gilt bronze frame --- twelve in all. There are also two types of studs on this ring. Twelve small studs conceal the pins which hold the whole construction together. These are surrounded in their bronze settings by gold filigree work. The

twelve large ones are in the centre of each frame. They are purely ornamental. The main decoration on these is coloured inlay and some tiny whorls of beaded wire in the centre of some.

The foot of the paten is a hoop of silvered bronze, the outer side of which contains twelve identical die-stamped panels of gilt silver.

### **3 TREASURES IN THE NATIONAL MUSEUM**

This chapter outlines the steps taken in the development of the multimedia package '**Treasures in The National Museum**'. In this case the users will be the children in 6th class in an inner city Dublin primary school. For evaluation purposes my target users are the children in my own school --- eleven and twelve year old girls, who live in a disadvantaged area. Many are unenthusiastic and lacking in general motivation. Old fashioned methods of teaching i.e. chalk and talk, are no longer sufficient to foster in these children the desire to learn. Education is not a priority in many homes, books are seldom read, visits to the museum are a rarity. Also many of these children spend a lot of time passively watching television and videos, have a poor attention span and their ability to concentrate is limited. We received computers recently as part of the Irish Tech Corps pilot scheme and the children love using them.

#### **Objectives:**

- 1) To present comprehensive information on the four items in '**The Treasury**' of the National Museum.
- 2) This information is to be presented in a multimedia environment to hold attention and facilitate the assimilation of the concepts involved.
- 3) To emphasise the interactive nature of the material the children are to be allowed to determine their own path through the material, although there will be some restrictions introduced in certain areas.
- 4) To present the material in a hierarchical way, using G.U.I. methodology.
- 5) To integrate the pedagogic material with jigsaws and quizzes to help maintain interest in the material.
- 6) To ensure a better appreciation of the selected artefacts in '**The Treasury**', -- under the headings of **Ornamentation, Decoration Techniques** and **Craftsmanship** -- during a follow-up visit.

The communication styles chosen for the interface are:

1) Menu Selection: This is effective as it uses the more powerful human capability of recognition rather than the weaker, recall. Choices can be indicated with the use of a pointing device. In the Main Menu Screen the artefacts are clearly and distinctly labelled so children can be confident in making selections.

2) Direct Manipulation: The children can move and transform objects on the screen as if they were real objects. They give no instructions, they simply act. This is easy to learn and the feeling of control it gives, appears to give children pleasure. This technique is the obvious choice for the assembly of the jigsaw and for the design of the children's own 'artefact'.

### **The Multimedia Program:**

This is a program for senior primary school children, aged eleven and twelve years of age. Its function is to prepare children for an enriching visit to **The Treasury of The National Museum**. It presents an interactive learning environment that focuses the children's attention on the selected artefacts.

It is a multimedia package executed in Visual Basic 4.00. Visual Basic 4.00 allows for the design and drafting of the interface, before incorporating any functionality into the program. Each screen, to be presented to the user, is drafted on a **Form**. The objects to be placed on this form are presented in the toolbox. From this they can be selected and placed on the form. The properties of each object are then defined. Again a table of these properties is presented and they can be customised to suit requirements. These properties determine the object's name colour, size, location and appearance on the screen.

The program consists of 36 interlinked screens(Fig. 1) dealing with **The Ardagh Chalice, The Derrynaflan Chalice, The Tara Brooch, and The Derrynaflan Paten**.

- The Opening Screen, **Treasures Main Menu** displays pictures of the four objects, as a brief audio clip tells the children where they are to be found in The National Museum. In order to use audio clips the **multimedia control** must be imported on to the form. This is displayed as a panel of buttons similar to any media player i.e. Play, Pause, Stop, Review, Record etc. Its properties must then be defined, ensuring that it is not actually visible to the users and that it is enabled automatically as the form is activated. This is implemented using the following code:

```
Private Sub Form Activate ( )  
MMControl1.filename = "a:\ intro.wav"  
MMControl1.Command = "Open"  
MMControl1.Command = "Play"  
End Sub
```

Each artefact can then be explored in turn by clicking on the command button beside its image. For example within the **Click** procedure behind the command button **Ardagh Chalice** the following piece of code is written:

```
Private Sub cmdArdagh Click ( )  
Form4.Show  
Me.Hide  
End Sub
```

For each artefact this selection leads to its own Main Screen and conceals the Main Menu Screen. This Main Screen shows a larger image of the item. An audio clip of the on-screen text plays, so that the children may read and hear the information simultaneously. The purpose of this is to grab the children's attention and to help language development. Along the bottom of the screen are placed command buttons labelled **Parts, Decoration, Quiz** and **Quit**. The child may then explore the object by selecting one of the command buttons. However the **Quiz** button will not be activated

until the other options have been explored. If the child selects the quiz, out of turn, a message box will display the text **'You must use the other options first!'** This involves placing the command buttons Parts and Decoration in an array and using the following two pieces of code:

(1)**Private Sub cmdOption Click ( Index As Integer)**

**cmdOption(Index).Enabled = False**

**Select Case Index**

**Case 0 'Parts**

**Form5.Show**

**Case 1 'Decoration**

**Form2.Show**

**End Select**

**End Sub**

(2)**Private Sub cmdQuiz Click ( )**

**If cmdOption(0).Enabled = True Or cmdOption(1).Enabled = True Then**

**MsgBox "You must use the other options first!",64,"Information  
Message"**

**Exit Sub**

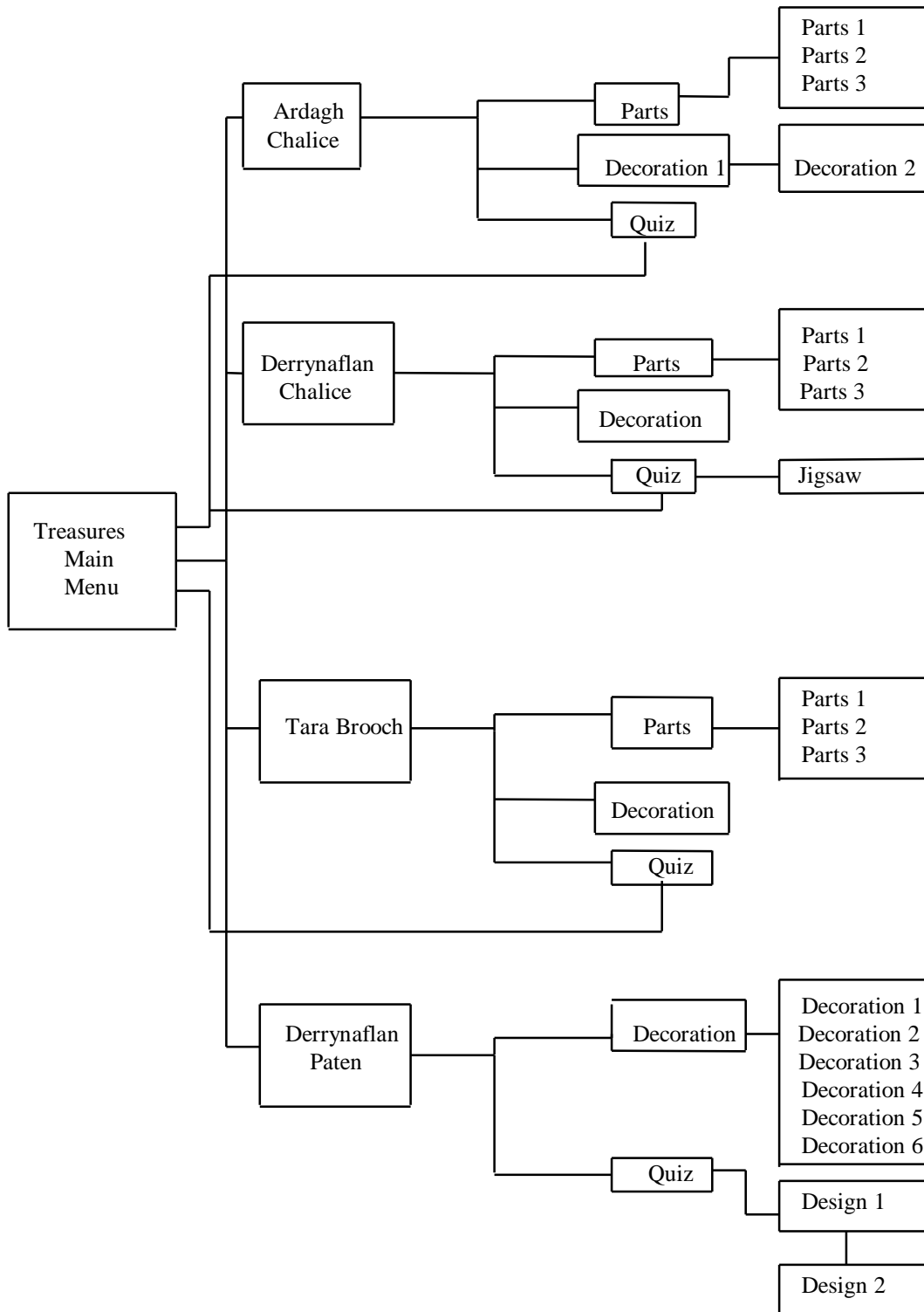
**End If**

**Form9.Show**

**End Sub**

- **'Parts'** leads to a screen where the various components of the artefact are labelled with command buttons. As these command buttons are selected more detailed information, including a larger image of the component, is displayed.
- **'Decoration'** displays screens which give information on the various ornamentation techniques employed in the decoration of the artefacts i.e. filigree, engraving, die stamping, trichinopoly etc.
- **'Quiz'** leads to a series of eight questions on the selected artefact. The children choose the correct answer from among three options. They use the mouse to click on the correct answer. If the correct answer is chosen their quiz score is increased by one point. If, however they choose a wrong answer a message box appears, which tells them it is wrong. In order to implement the quizzes the following procedure is used:
  - 1) A **Text Box** is used to pose the questions.
  - 2) A **List Box** is used to offer three choices of answer, the correct one to be chosen by double clicking.
  - 3) A **Command Button** is used to move on to the next question, by clicking with the mouse.
  - 4) A **Text Box** is used to accumulate the score.

Fig. 1 Tree Diagram for 'Treasures in The National Museum'



- After fully exploring **The Ardagh Chalice** and **The Derrynaflan Chalice** the children are then given access to a **Jigsaw Screen**. By dragging and dropping pieces they reassemble both chalices. The purpose of this is to draw their attention to the differences between the two chalices. These have already been referred to in the previous chapter.
- When the children work their way through all the material and the quizzes on the four artefacts they are then given access to a **'Design Your Own Chalice' Screen**. By dragging and dropping pieces they can assemble a chalice comprising a mixture of the components from both **The Ardagh Chalice** and **The Derrynaflan Chalice**.
- They may then move on to another screen, **'Design Your Own Artefact' Screen**, which allows them to manipulate pieces from the four artefacts into various combinations. This interaction is provided with the purpose of familiarising the children with the 'details' of the objects.

#### **4 ANALYSIS AND EVALUATION**

The purpose of this chapter is to analyse and evaluate the implementation of the program 'Treasures in The National Museum' and to assess the value of such a program as a means of enhancing children's appreciation of the selected artefacts. For this purpose two classes in Scoil Mhuire Ogh 1 were used i.e. my own class and another 6th class group. As the multimedia package was used with only 24 children it is difficult to make any general claims regarding its value. However the children with whom it was used are identical to the other class group in many respects i.e. age, sex, ability levels, background and computer literacy. Therefore I believe that, as a pilot study, it is acceptable to make comparisons between the two groups regarding the value of such a multimedia package. Because of the size of the sample group used quantitative analysis is of limited value. Therefore while I do present some numerical findings most of my analysis is of a qualitative nature.

There were 24 children in each group. From now on the children who used the computer program will be referred to as the experimental group, while the other class will be referred to as the control group.

The control group was brought to visit 'The Treasury' in The National Museum in groups of four. Each child was given a set of questionnaires on the four artefacts --- The Ardagh Chalice, The Derrynaflan Chalice, The Tara Brooch and The Derrynaflan Paten. The children were given a brief introduction to the four artefacts and watched the audio visual presentation in the museum on 'The Treasury'. They were instructed to view the artefacts and to use the strategically placed text to complete the questionnaires.

The experimental group worked through the multimedia program 'Treasures in The National Museum', in pairs, in the classroom. They were then brought to the museum, in groups of four, to view the artefacts.

As each group of children returned from their visit to the museum they answered a 32 question multiple choice quiz on the four artefacts.

Based on the scores attained on these quizzes, on observations made during computer sessions and during the twelve museum visits comparisons are made between the two groups.

### **Qualitative Analysis**

#### **1) Interaction with the Computer Program and Artefacts:**

The experimental group used the program with no difficulty. Each pair worked through it in two sessions --- exploring the Ardagh Chalice and the Derrynaflan Chalice in the first session and the Tara Brooch and Derrynaflan Paten in the second session.

There were vast differences between the experimental group and the control group in the way they interacted with the artefacts themselves in the museum.

Very few members of control group made use of the text displayed in the area, unless prompted to do so. As the children in this group approached the display cases many appeared disoriented. Some wandered from case to case, viewing the artefacts very briefly, and then proceeded to work on their questionnaires. The worksheets seemed to be the main focus of their attention. They used the artefacts merely to help them answer the questions.

The experimental group studied each artefact very closely. They searched out the parts and decoration techniques they had learned about in the computer program.

Most expressed surprise at the fine detail in the decoration techniques and in the filigree panels in particular. Having sought out specific panels which had been presented in the computer program, they then tried to interpret, previously unseen, designs in the filigree panels on the Ardagh Chalice and the Derrynaflan Chalice.

They also viewed the artefacts systematically, exhausting all parts and decoration techniques used, before leaving one artefact to move on to the next one.. Most of them noted the differences between the Ardagh Chalice and the Derrynaflan Chalice in terms of intricacy of filigree and in colour, reaching the conclusion that the workmanship in the former was a good deal superior to the latter. They displayed great interest in the methods used by the craftsmen and generally formed the opinion that they "must have taken years" to produce each of the four objects. In their discussions they were keen to use the correct terms for the various parts and decoration techniques used.

#### **2) Time spent on museum visits:**

The times spent on the museum visits did not vary greatly among the twelve individual groups. The visits began with the 18 minute audio visual presentation. The rest of the time was spent in 'The Treasury'. This time was generally between 30 and 40 minutes. However how this time was utilised did vary.

The children in the control group spent all their time working on their questionnaires. If individual children finished before others they generally used the time to wander casually around the rest of 'The Treasury', in a manner similar to other museum visitors. The children in the experimental group used all their time to view the four objects spending, in some instances, up to 10 minutes viewing one particular artefact. This far exceeded the length of time spent by any other visitors observed during our visits.

### **3) Collaboration:**

The children in the control group did collaborate when filling in their questionnaires. They discussed questions among themselves but in general were not inclined to seek out, or to ask me for, assistance.

The experimental group, while working in pairs at the computer, did not discuss content to any great extent. Their collaboration involved sharing tasks i.e. using the mouse to select buttons, complete jigsaws and designs and to answer questions.

During their museum visits there was a great deal of collaboration. Each group of four, except one, did in fact view each object together, discussing each one in detail, helping one another locate various filigree panels, engravings etc.

### **4) Questions asked by children:**

While the children in the control group did not ask very many questions, those they did ask, related to difficulties they had with terms used in the questionnaires. On the other hand the children in the experimental group asked questions relating to the artefacts themselves and the decoration techniques used e.g. ---

“How did they put the wires in place in the filigree panels?”

“What was the chain for on the Tara Brooch?”

“How did they get the silver pieces into the glass studs?”

“What kinds of tools did they use to put the tiny blobs of gold on the studs?”

They also asked museum staff questions regarding what they could not see i.e. the underside of the Derrynaflan Paten.

### **5) Comments made by children:**

Most of the children had visited the museum previously on a 'whistle stop tour' of the whole museum. For the purposes of this experiment their visits were much more focussed and a general comment made by most of them was that the objects they looked at were 'deadly' i.e. very beautiful indeed. However when pressed on issues such as their favourite item and the reason for their choice the children in the experimental group had, in general, specific reasons for their preferences e.g.

“The studs on the Ardagh Chalice make it much more colourful.”

“The filigree panels on the Ardagh Chalice are much more complicated than the ones on the Derrynaflan Chalice.”

“The Derrynaflan Chalice is very dull compared to the Ardagh Chalice.”

There was a general consensus within this group that using the computer beforehand had been very advantageous as they 'knew exactly what to look for in the different objects'. They also remarked that seeing, for example, some of the filigree

panels in the Derrynaflan Paten in the computer program 'made it easier to find them on the paten itself'. Some commented that even though they had seen the objects before they had not realised that 'there were so many different things to be seen on them'.

### **Statistical Analysis:**

This analysis is based on the scores attained by the children in the quizzes (Appendix 1). While the number involved in this experiment was too few to make any definite judgements based on differences in scores, it is however worthwhile to note comparisons and differences where they occur.

Both groups completed two rounds of quizzes --- the control group completed the first round during their museum visits, while the experimental group completed theirs as part of the multimedia program. For this round the children collaborated. Then on their return from the museum each child completed the second round of the quiz i.e. 32 multiple choice questions, eight on each of the four artefacts. On this occasion each child worked alone.

The average scores of the control group and the experimental group in the Ardagh Chalice Quiz Round 1 are 4.3 and 4.9 respectively. This information however tells us little about the spread of scores. While none of the children in the experimental group scored the maximum result, the majority of them scored 4 or higher. The control group, on the other hand, had scores in the range 1 to 8.

Again the range of scores in the Derrynaflan Chalice Quiz Round 1, within the experimental group is not as great as that of the control group. The score which occurred with greatest frequency within the experimental group was 6, while scores of 4, 5 and 6 occurred with the same frequency within the control group.

The distribution of scores in the Tara Brooch Quiz Round 1, within the experimental group almost follows the pattern of a Normal Curve, while those of the control group does not display any definite pattern.

There are marked differences in the scores, in the Derrynaflan Paten Quiz Round 1, between the control group and the experimental group. The scores attained by those in the experimental group are all in the range 4 to 8 with the majority scoring 7 or 8. The scores attained by those in the control group, on the other hand, range from 2 to 8 with only one person scoring 8 and no one at all scoring 7.

The total scores attained in Round 1, by the children in the control group range from 10 to 26 out of a possible 32. The scores attained by the experimental group range from 18 to 25. While there is no significant difference in the higher end, the range in the experimental group is, once again much narrower. While all the children in the experimental group, except one, scored 4 or higher in second round of the Ardagh Chalice Quiz the highest score attained by those in the control group was 5, while more than half of them scored 4 or lower.

Once again, while there is little difference between individual scores in Rounds 1 and 2, of the Derrynaflan Chalice Quiz, the majority of the scores within the

experimental group fall in the upper half of possible scores. None of the children in the control group scored higher than 6.

The scores attained by the experimental group in the second round of the Tara Brooch Quiz are once again concentrated in the upper half of the possible range, while the maximum score attained by those in the control group was 6, with 10 children scoring 3 or lower.

Once again there is a marked difference in the distribution of scores in the second round of the Derry-naflan Paten Quiz, with the experimental group having an average score of 5.8 while the control group's average score was 3.7.

The total scores attained in Round 2, by the children in the control group range from 10 to 22 out of a possible 32. The scores attained by the experimental group rang from 15 to 27. While the range of scores is the same for both groups 16 children in the experimental group scored 20 or higher, only 2 children in the control group attained such a score.

### **Key Findings:**

- While there was not a great deal of difference between the length of time spent in the museum by the two groups, how that time was used by them was quite different.
- The children in the experimental group spent a great deal more time interacting with the artefacts than those in the control group.
- The children in the experimental group were very interested in the details of the artefacts.
- The questions asked by the children in the experimental group related to the decoration techniques used on the artefacts.
- There was a great deal of collaboration among the children in the experimental group during their museum visits.
- Generally, the scores attained by the experimental group in the quizzes were in the upper half of the possible scores, while there was, in most cases, a greater spread of scores among those in the control group.

## **5 CONCLUSIONS AND SUGGESTIONS FOR FUTURE WORK**

### **Conclusions:**

It would appear to be the case that, in general, the children in the experimental group had a more enriching visit to the museum than those in the control group. They definitely displayed a greater interest in the artefacts. It could be argued that any preparation made before such a visit would be beneficial. It need not necessarily be done through the use of computer. While this is true it would seem that the computer offered more possibilities than the traditional means of preparation i.e. reading about the artefacts.

I believe that using such a program would be of more benefit to the children if used in the classroom situation ( as it was in this study) prior to the museum visit,

rather than having it available during the visit. While the use of multimedia in museums is increasing in popularity the difficulties associated with it include ---

- 1) The material included needs to be pitched at the 'average' visitor. Therefore children may have problems using it.
- 2) It is necessary to have some 'substance' in the material for it to be of value. This implies that a sizeable amount of time is needed to use such programs, causing queues or incomplete use being made of them.
- 2) As evidenced by the use of the questionnaires with the control group, focus can easily be diverted from the main purpose of a museum visit i.e. viewing the artefacts. Therefore, while there is a need to direct children's visits, one must be careful not to distract them from their interaction with the artefacts. For this reason I would see that using a multimedia program beforehand would enhance the visit, rather than detract from it, which could be the case if children became involved in using the computer in the museum.

In accepting that the multimedia program proved itself of to be value to the children, it is necessary to outline the limitations of the program, which could be addressed if it were further developed.

## **6 SUGGESTIONS FOR FUTURE WORK**

- 1) The computer images are two dimensional and thus unless a number of views of an object is included it is impossible to achieve a three dimensional effect. This is one of the reasons why such a computer program could never be viewed as a replacement for the field trip to the museum. It should be looked upon as an extra aid available to the museum visitor in his pursuit of an enriching visit. The fact that children asked what the underside of the Derrynaflan Paten was like, indicates the need to use some graphics package which would allow the artefacts to be 'rotated' so that a multiplicity of views could be achieved.
- 2) The quality of the images used could be greatly improved to show the fine detail in the decoration techniques. If this program was to be developed this issue would have to be addressed.
- 3) The children were afforded the opportunity to interact with the objects, even if only a two dimensional representation of them. Improvements in the manipulations possible would need to be included i.e. some method of allowing the individual pieces to be rotated so that the users would have greater scope for their use. In order for the children to gain more insight into the decoration techniques used on the artefacts, the interaction could be developed further --- designing their own filigree panels or patterns on glass studs. They could also be presented with line drawings of the objects, which they could then decorate using the various appropriate techniques.
- 4) It is difficult to convey accuracy as regards the size of the artefacts. Many of the children expected them to be much larger in reality, as a result of the impression created by the computer program and the audio visual presentation.. This could be overcome by incorporating some video footage showing the craftsman at work.

5) As sound is an important aspect of children's interactive programs, and the children expressed a desire for more sound, its use could also be extended. Sound was used to complement text, whereas in an improved program it could be used in the context of an 'ask the expert' element. The craftsman could explain the processes involved in his craft.

6) The historical context of the artefacts could also be developed using a 'time line' presentation or 'life in a monastic settlement', with its various inhabitants, including the metalworker, the scribe etc.

I conclude that, given a longer time frame, than this dissertation allowed, and improved resources, using a multimedia program with children prior to bringing them on a visit to the museum would enrich their visit and enhance their appreciation of the museum artefacts. I also conclude that there is a case for having such programs available to schools which could introduce the pupils to different sections of the museum e.g. The Egyptian Room, The Treasury etc. This would, hopefully, encourage greater use of the National Museum as an irreplaceable resource available to teachers for the teaching of history.

## References

- (A.T.L.1983)Lucas, A.T.: Treasures of Ireland --- Irish Pagan and Early Christian Art - a commentary by A.T.Lucas. Gill and Macmillan 1973.
- (B.C. 1988) Bradley Commission on History in Schools.Building a history curriculum: Guidelines for teaching history in schools, Washington,D.C.: Educational Excellence Work 1988.
- (B.D.B.19 83)De Breffney, Brian: Ireland: A Cultural Encyclopaedia. Thomas and Hudson Ltd. (1983)
- (B.S.1989)Shneiderman, B.: Editing and Managing Hypertext in Authoring. E. Barret (Ed.) The Society of Text, MIT Press, MA, (B.S.D.S.1990)Sponder, Barry; Schall, Dennis: The Yugtarvik Museum Project: Using Interactive Multimedia for Cross-Cultural Distance Education. Academic Computing, April 1990.
- (C.D.1996)Davis, Courtney: Celtic Ornament --- The Art of The Scribe. Blandford USA.(1996).
- (C.G.S.1986)Screven, C.G.: Educational Exhibitions: Some Areas for Controlled Research. Journal of Museum Education Round Table Reports Vol. 11 No. 1 1986.
- (D.M.S.1988)Seiter, David M.: Resources for Teaching with Computers in History. History Microcomputer Review Vol. 4 No. 2 1988.
- (D.R.R.W. 1989)Ramos, D.; Wheeler, R.A.:Integrating microcomputers into the history curriculum. The History Teacher 22, 1989.
- (D.S. 1966) Stones, D: An Introduction to Educational Psychology, Methuen, London.
- (D.T.S.G.1991)Tsichritzis, Dennis; Gibbs, Simon: Virtual Museums and Virtual Realities. International Conference on Hypermedia and Interactivity in Museums 1991.
- (E.A.Y.J.M.1995)Yaeger, Elizabeth Ann; Morris, James (iii): History and Computers: The Views from Selected Social Studies Journals. Social Studies Vol 86. Dec.1995.
- (E.P.K.1993)Kelly, Eamonn P.: Early Celtic Art in Ireland. Country House, Dublin and National Museum of Ireland 1993.
- (H.R.1935)Read, H.: The Meaning of Art. Faber and Faber (1935).
- (J.C.1992)Chadwick, John: The Development of a Multimedia Program and The Effect of Audio on User Completion Rate. Journal of Multimedia and Hypermedia (1992), 1.
- (J.H.1991)Hoekema, Jim: Treasures of The Smithsonian --- A Museum Orientation You Can Take Home. International Conference on Hypermedia and Interactivity in Museums 1991.
- (J.K.,M.L.K. )Koran, John J. Jr.; Koran, Mary Lou: A Proposed Framework for Exploring Museum Education Research.
- (J.R.1993)Rees, Jeremy: Interactive Multimedia : The Brancusi Project - An Exploration in International Collaboration. Information and Services and Use 13 I.O.S. Press 1993.
- (K.W.T.W.1990)Wilson, Kathleen; Tally, Wilson: The Palenque Project: Formative Evaluation in the design and development of an optical disc prototype. Hillsdale N.J.: Lawrence Erlbaum Associates, Publishers 1990.

- (K.W.1991)Wilson, Kathleen:Multimedia Design Research for The Museum Education Consortium's Museum Visitor's Prototype. International Conference on Hypermedia and Interactivity in Museums1991.
- (L.L.C.P. 1987)Levstik, L.; Pappas,C.:Exploring the development of historical understanding. Journal of Research and Development in Education 21, 1987.
- (M.E.M.1986)Munley, Mary Ellen: Back to The Future: A Call for Co-ordinated Research Programs in Museums.Journal of Museum Education Round Table Reports Vol.11 No.1 1986.
- (M.R.1983)Ryan, Dr. Michael (Ed):The Derrynaflan Hoard 1 - A Preliminary Account. National Museum of Ireland 1983.
- (M.R.1985)Ryan, Dr. Michael:Early Irish Communion Vessels. National Museum of Ireland Guide 1985.
- (M.R.1993)Ryan, Dr. Michael: Metal Craftsmanship in Early Ireland. Irish Country House 1993.
- (N.C.E.T.1989)National Council for Educational Technology (1989): Using Computer Simulations in History.
- (N.D.D.P.M.Z.Y.V.1993)Dessipris, Nikolaos G.; Pandermalis, Dimitrios; Zambelaki, Marianthi; Vassiliadou, Yianna: The Electronic Guide to The Museum of Dion. Information Services and Use 13 I.O.S. Press(1993).
- (N.M.I.) All photographic material and illustrations of The Ardagh Chalice, The Derrynaflan Chalice, The Tara Brooch and The Derrynaflan Paten used in the program, Treasures in The National Museum, have been used with the permission of the rights and reproductions department of The National Museum.
- (R.D.T.R.G.1983)Teitelbaum, R.D.;Granda,R.:”The effects of positional constancy on searching menus for information”. Proceedings: CHI 1983.
- (R.I.A.1983)Ryan, Dr. Michael (Ed): Treasures of Ireland --- Irish Art 3000B.C. - 1500A.D.Royal Irish Academy 1983.
- (R.K.M.P.L.M.H.1996)Munro, R. K.; Hillis, P.L.M.: Bright Ideas, Creative People, Teamwork and Money --- Developing Courseware for Teaching Scottish History. History Computer Review 1996.
- (R.L.W.1986)Wolf, Robert L. Ph.D.: The Missing Link: A look at The Role of Orientation in Enriching The Museum Experience. Journal of Museum Education: Round Table Reports Vol. 11 No. 1 1986.
- (R.W.1994)Wayment, Ralph: Active, Interactive and Immersive Multimedia in Gallery Environments. Information Services and Use 1994 Vol.14 No. 3 I.O.S. Press.
- (S.A.1991)Alsford, Stephen: Museums as Hypermedia: Interactivity on a Museum Wide Scale. International Conference on Hypermedia and Interactivity in Museums (1991).
- (W.G.1997)Galitz, Wilbert O.: The Essential Guide to User Interface Design, Wiley Computer Publishing, 1997.
- (WWW1)<http://es.rice.edu/ES/humsoc/Galileo>
- (WWW2)<http://wwwhistoryactive.com>
- (WWW3)<http://wwwncet.org.uk>
- (WWW4)<http://wwwncl.ac.uk/~nantiq>

## APPENDIX 1

Round 1 and Round 2:

- 1st Score = Score in Ardagh Chalice Quiz  
 2nd Score = Score in Derrynaflan Chalice Quiz  
 3rd Score = Score in Tara Brooch Quiz  
 4th Score = Score in Derrynaflan Paten Quiz

Control Round 2	Round 1	Round 2	Experimental	Round 1
Pupil 1 4+5+4+4 = 17	4+4+6+1 = 15	Pupil 1 6+5+5+6 = 22	6+6+7+6 = 23	
Pupil 2 6+5+4+2 = 17	5+5+4+2 = 16	Pupil 2 6+5+5+6 = 22	5+7+5+3 = 20	
Pupil 3 1+4+6+2 = 13	1+3+5+4 = 13	Pupil 3 3+7+4+8 = 22	5+6+5+6 = 22	
Pupil 4 4+6+6+3 = 19	4+5+4+2 = 15	Pupil 4 3+7+4+8 = 22	6+6+6+8 = 26	
Pupil 5 5+4+5+2 = 16	5+3+5+2 = 15	Pupil 5 7+6+4+8 = 25	7+6+6+7 = 26	
Pupil 6 5+3+5+3 = 16	1+5+2+3 = 11	Pupil 6 6+4+3+6 = 19	5+4+4+7 = 20	
Pupil 7 5+6+5+2 = 18	3+6+4+4 = 17	Pupil 7 7+6+2+4 = 19	5+7+3+4 = 19	
Pupil 8 4+5+6+3 = 18	5+4+4+3 = 16	Pupil 8 7+6+4+8 = 25	6+6+7+8 = 27	
Pupil 9 5+5+3+6 = 19	5+2+3+4 = 14	Pupil 9 7+6+2+4 = 19	6+4+4+4 = 18	
Pupil 10 4+6+3+3 = 16	4+4+4+4 = 16	Pupil 10 5+3+3+7 = 18	2+6+2+5 = 15	
Pupil 11 3+6+3+6 = 18	3+5+3+3 = 14	Pupil 11 6+3+3+6 = 18	4+3+3+6 = 16	
Pupil 12 4+6+3+4 = 17	2+6+2+3 = 13	Pupil 12 5+3+3+7 = 18	2+6+2+5 = 15	
Pupil 13 5+5+4+6 = 20	4+4+1+5 = 14	Pupil 13 5+5+4+8 = 22	8+4+5+3 = 20	
Pupil 14 4+7+4+8 = 23	5+4+4+6 = 19	Pupil 14 4+4+4+7 = 19	5+5+4+7 = 21	
Pupil 15 4+2+4+5 = 15	3+2+4+5 = 14	Pupil 15 5+4+6+7 = 22	5+5+6+5 = 21	
Pupil 16 2+3+2+5 = 12	2+2+2+4 = 10	Pupil 16 3+5+5+8 = 21	6+6+5+6 = 23	
Pupil 17 3+4+5+3 = 15	5+5+5+3 = 18	Pupil 17 4+6+3+6 = 19	5+2+3+5 = 15	
Pupil 18 3+4+2+4 = 13	3+3+3+2 = 11	Pupil 18 3+5+4+8 = 20	4+4+4+5 = 17	
Pupil 19 2+4+1+3 = 10	2+2+3+3 = 10	Pupil 19 4+5+4+7 = 20	6+5+4+6 = 21	

Pupil 20	$3+5+3+5 = 16$	$3+4+3+6 = 16$	Pupil 20	$4+6+5+7 = 22$	$4+7+3+7 = 21$
Pupil 21	$6+3+6+6 = 21$	$4+3+3+6 = 16$	Pupil 21	$6+6+5+7 = 24$	$7+5+5+7 = 24$
Pupil 22	$8+6+6+6 = 26$	$5+6+6+5 = 22$	Pupil 22	$6+6+3+7 = 22$	$7+4+6+7 = 24$
Pupil 23	$8+4+6+6 = 24$	$5+5+4+6 = 20$	Pupil 23	$3+6+4+7 = 20$	$5+4+3+5 = 17$
Pupil 24	$6+3+6+6 = 21$	$5+4+6+3 = 18$	Pupil 24	$4+6+5+8 = 23$	$6+6+7+7 = 26$