THE FILTER GENERIC IMAGE DATASET: A MODEL FOR THE CREATION OF IMAGE-BASED LEARNING & TEACHING RESOURCES

Jill Evans
Institute for Learning and Research Technology
University of Bristol, UNITED KINGDOM
jill.evans@bristol.ac.uk

Abstract

There are clearly numerous opportunities for the academic community to take advantage of the wealth of digital images that are available online for the purpose of resource creation. There remains, however, a general lack of understanding of how to use images effectively for learning and teaching. In certain subject areas images are under-used, possibly because of a lack of understanding of the important role images can play in the support of learning, teaching and research. The education community needs advice and guidance on how to integrate images with teaching activities, on use of standards and how to adhere to good practice. The FILTER project aims to support and encourage potential users of digital images through the provision of effective and appropriate examples of image use in a range of pedagogical contexts. FILTER is working with academics to create these subject-specific datasets together with a generic image dataset which can be freely downloaded and easily adapted by users.

Keywords

Images, Digital Images, Learning and Teaching, Standards, Good Practice

Introduction

Images increasingly play a part in all aspects of our lives. The proliferation of media that communicate information via visual paradigms means that we are growing more adept at understanding and interpreting image content and meaning (Kress & van Leeuwen, 1996; Mitchell, 1994). A new generation of learners that has grown up surrounded by constant visual stimuli, such as video and computer games, has become sophisticated in its ability to assimilate and process the data contained therein. These students now expect that a high percentage of their learning should be transmitted visually (Kirriemuir, 2002; Becta, 2002).

Gaining access to digital images is no longer a problem. There are now millions of images freely available over networks and, with increasing access to digitisation equipment, people are easily able to create their own digital images. These images present an opportunity for the educational community to create stimulating and cost-effective visual resources. Images are an essential component of education, having always been used to support learning and teaching in a variety of ways. Images provide access to complex visual information and experiences that cannot be replicated in purely textual terms: "Pictures interact with text to produce levels of comprehension and memory that can exceed what is produced by text alone" (Levin, 1989). The Support Initiative for Multimedia Applications (SIMA) investigated the use and capture of images for teaching and learning. This study concluded that visual materials can, when used appropriately, enhance learning, “Being non-text intensive, the computer environment is ideal for the use of images to enhance learning” (Williams, Lock, Crisp & Longstaffe, 1995). It is also commonly accepted that users prefer and respond more positively to materials that contain visual elements (Duchastel & Waller, 1979; Levie & Lentz, 1982). Research has established that recall and

memory is improved when information is presented visually, or supplemented by use of images (Paivio, Rogers & Smythe, 1968; Standing, Conezio & Haber, 1970; Paivio, 1971; Standing, 1973; Paivio, 1975).

There remains, however, a general lack of understanding of how to use images effectively for learning and teaching (Evans, Conole & Youngs, 2001; Grout, 2001; Williams et al., 1995). The community needs advice and guidance on how to integrate images with teaching activities, on use of standards and how to adhere to good practice. There is also a need for greater understanding of the purpose and need for metadata for visual information. Several recent initiatives have attempted to increase the use of existing resources and collections, by providing advice and exemplars of good practice. The Promoting the use of On-line Image Collections in Learning and Teaching In the Visual Arts project (PICTIVA, http://vads.ahds.ac.uk/learning/pictiva/) aims to promote image collections by developing generic tools to support access to the images, producing supporting materials, advising on evaluation of tools and materials, and producing a series of case studies. Similarly, the Enhancing the Bristol BioMed for Learning and Teaching project (BB-LT, http://www.brisbio.ac.uk/bblt/) has developed a series of 'How-to' guides, case studies and tutorials to promote and facilitate the use of images in the biomedical communities. Finally, the Focusing Images for Learning and Teaching – an Enriched resource project (FILTER, http://www.filter.ac.uk/) is extending this framework to provide exemplars of effective image use across subject areas, and both generic and subject-specific learning and teaching resources.

The FILTER Project

The FILTER project grew out of an increasing awareness that digital images and image-based resources were not being taken up by the community in the way that was expected (Conole, Evans & Sims, 2002). A FILTER survey of the academic community revealed that there were a number of common problems preventing the uptake of images, including: lack of technical skills; uncertainty over how to use images for maximum impact and effectiveness, how to use images in different contexts with different groups of learners, and how to use images with students of different levels of ability; lack of time to create resources or learn the necessary skills (Evans et al., 2001).

Whilst certain subject areas such as the Visual Arts and Medicine have a strong tradition of using images for learning and teaching, there are other subject areas, such as History or English, where images have been used very little and in limited contexts. FILTER is working in these subject areas to try to encourage the use of digital images and also to provide initial guidance and practical examples that can easily be downloaded and adapted. A number of academics have been commissioned by FILTER to produce subject-specific image datasets. These datasets include: a set of images, a teaching resource in which these images are used, a case study documenting the process of resource creation, supplementary materials such as how-to guides, and metadata, i.e. text describing the resource and the images. The datasets are being compiled in a database which will be freely available to anyone from the tertiary education community.

The principal aim of the FILTER image datasets is the illustration of effective and appropriate use of images for learning and teaching in specific subject domains. However, FILTER is also encouraging people to look beyond their own subject areas so that they may discover novel ways in which images are used in other subject areas and adapt these for use with their own students. One of the main objectives of FILTER is to facilitate this cross-subject transference and sharing of knowledge and skills. Equally important, is to provide accurate, consistent metadata for the management, discovery and retrieval of resources.

In addition to the subject-specific datasets, FILTER is producing a generic image dataset. The dataset contains all the components of a subject-specific dataset, but in generic form. It is intended to be used by lecturers and teachers of all levels of ability and experience in digital image use to assist in the creation of their own subject-specific datasets.

Methodology

The FILTER generic image dataset is currently being developed alongside the creation of the first six subject-specific datasets. The six authors have been given guidelines and templates to help them in their dataset creation and to ensure consistency and high quality of materials. These initial guidelines were based on those developed by the BB-LT project, which successfully delivered a series of learning and teaching resources based on images from the Bristol BioMed archive. On completion of their datasets, authors submit materials online and complete a metadata form for 1) the teaching resource 2) each image in the resource 3) the dataset.

FILTER Activities

In compiling and adapting the model for dataset creation, FILTER has carried out a range of data gathering and formative evaluation activities. Results and findings from these activities have been iteratively fed into development and refinement of processes and procedures. The creation of the first six datasets has been treated very much as an experimental process; feedback from authors and close monitoring of materials development ensure that any issues or problems can be addressed in order to facilitate the smooth running of the second round of authorship, involving a further 10-14 authors.

Activities include:

- An initial online questionnaire surveyed the academic population in order to gain an understanding of the current use of digital images and identify issues that could present a barrier to potential uptake
- A national focus group of practitioners and experts allowed further in-depth discussion of digital image use and approaches to developing exemplars of good practice in image use
- An authors' workshop allowed focused discussion of issues arising from the first stage of dataset creation and preliminary assessment of the usability and clarity of guidelines and templates. Also discussed were the metadata schemas and ways of developing in-house vocabularies to be used within specific metadata elements (or fields)
- An authors' debriefing meeting held after completion of the first six datasets, permitting discussion of any problems or difficulties that arose, and allowing refinement of the dataset creation model for the second round of authors
- An online image description and categorisation exercise has allowed FILTER to build up a picture of the type of words and phrases that people use to describe both the subject content and "type" of specific images
- Peer-review of materials by both subject specialists and educational technology experts; peer-review is facilitated by use of a FILTER checklist, ensuring that all materials are evaluated against the same criteria
- A metadata questionnaire must be completed by authors once they have submitted their resources. Findings from the questionnaire are used to refine the process, to adapt the templates and to build the in-house vocabularies

The FILTER Generic Image Dataset

The generic image dataset consists of guidelines and templates for the creation of image-based teaching resources. It will be available from the FILTER Web site from Winter 2002/03 and will be freely downloadable. Methods of packaging the dataset for quick and easy downloading and use are currently being investigated. The dataset components are described in the following sections: Author guidelines; Image set guidelines; Resource guidelines; Case study guidelines; How-to guides guidelines; Image creation log guidelines; Metadata guidelines.

Author Guidelines

These are written guidelines that establish an overall structure and style for the creation and development of the dataset. Guidelines include a discussion of accessibility issues and advice on how to ensure that resources do not exclude certain categories of user through injudicious use of

colours, fonts or plug-ins, for example. The guidelines also provide advice on acceptable writing styles, spelling, terminologies, text-formatting, and so on, in order to achieve consistency and accuracy throughout.

Image Set Guidelines

The image set guidelines have been created in collaboration with the Technical Advisory Service for Images (TASI, http://www.tasi.ac.uk/) to provide guidance on finding and selecting images for the resource. Issues of quality are discussed and, for those wishing to create their own digital images, information on scanning and manipulation. This section also emphasises the importance of ascertaining the copyright of an image and gives advice on how image rights can be handled.

Resource Guidelines

The resource is the core of the dataset; the aim of the resource is to demonstrate the potential effective uses of images to support the learning and teaching process in a specific subject area (e.g. History, Biology, Engineering). A resource could be, for example: a Web-based tutorial written in HTML; a PowerPoint presentation; a quiz; an example of computer-aided assessment; a case study; a collection of activities based on a topic or theme. Choices of the type of resource to be created, the topic of the resource, the method of creation and the tools used are the author's, provided guidelines for ensuring maximum accessibility are followed. The resource topic may be as broad or as focused as desired, provided the resource demonstrates, as far as is possible, typical use of images within the wider subject area and has pedagogic aims and objectives (i.e. is not simply a collection of images).

Resource Component	Information Required
Introduction	Description of the resource; Objectives; Intended audience; Skills or knowledge required of audience; Minimum software and hardware requirements; Estimate of the time taken to complete (if applicable)
Resource Outline	Overview; Anticipated learning outcomes; Explanation of structure; Instructions
Resource	The main body of the materials; Links to additional resources, plug-ins, if required; A mechanism for marking of materials if appropriate; An assessment/evaluation of results; Feedback on answers
Additional Materials	Links to Web sites; Further readings; Suggested activities; Additional specialist tools, procedures etc; Next learning activity in the sequence
Conclusion	Summary of what has been learned; Reinforcement of key issues; Suggested further study/activities

Figure 1: FILTER template for resource creation

Case Study Guidelines

The case study documents the author's experience of creating the resource and includes information such as: how suitable images were identified, selected and prepared; learning and teaching objectives and proposed outcomes; what software was used to create the resource; the process of resource creation; problems and obstacles encountered, and so on. A template to aid case study production is provided. The case study is an essential component of the dataset, as it will provide information to enable a potential user to decide whether or not the resource is appropriate or relevant to their own academic environment or needs, if so, how it can be adapted and used, and how similar resources can be created from scratch.

How-to Guides Guidelines

The how-to guides are intended to provide practical guidance on using and integrating image resources with learning and teaching activities. Where possible, guides follow a sequential step-by-step format, ensuring that the process or procedure described is set out as clearly and simply as possible for the user. How-to guides focus on a particular aspect of image use and therefore do not

aim to be comprehensive. Authors are advised to avoid in-depth coverage of all the issues relating to a topic, but rather to provide links to further relevant Web-based materials, for example.

Image Creation Log Guidelines

The image creation log provides an historical account of how the digital images were captured, optimised and, if applicable, altered. Information in the log includes all technical details that might be useful in understanding the image and its history (e.g. date of capture, date of manipulation, colour management, scanning notes, software used, data source, and so on). This type of data can be useful to future users in providing information on image quality, authenticity and provenance. Users may be interested in the degree to which an image has been manipulated and the processes by which the manipulation was carried out. Users may also wish to know how far from the original source the digital copy has travelled; some visual deterioration may have taken place raising issues of quality, authenticity, reliability and suitability for pedagogical reuse.

The purpose of the image creation log is to record details of the image history and its provenance. The image digitisation and manipulation process can, if not undertaken carefully, result in deterioration in image quality. This may lead to an image becoming unsuitable for certain learning and teaching situations. For example, if a medical image is to be useable and reliable for the purposes of diagnosis, it is critical to be aware of any previous manipulation which could mislead the viewer and affect the accurate interpretation of the subject content. In the case of a digital image of a work of art, it is important for the user to be informed of both the original source of the image, for example a sculpture by Rodin, and of the photographer of the sculpture, from which the digitised version is derived. The farther a digital image travels from its original source, the more likely it is to undergo some sort of loss in quality. The manner in which an image has been digitised and the transitions it has undergone can affect re-use. In order for the potential user to be able to make an informed decision on the suitability of an image for a particular pedagogical context, he/she must have access to information on the authenticity and reliability of the image.

The following template for recording image information is based on existing schemas and specifications developed by NISO (http://www.niso.org/committees/committee_au.html), the Visual Resources Association (http://vraweb.org/vracore3.htm) and the Art Museum Image Consortium (http://www.amico.org/AMICOlibrary/dataDictionary.html).

Field	Commentary
Image source	Slide sample, painting, map, and so on; if a work of art note details of artist
Original work type	E.g. slide, photograph, x-ray
Original work size	E.g. 4”x5”, 35mm
Date of work	
Date of digitisation	
Capture device used	E.g. digital camera, flatbed scanner
Digital image dimensions	E.g. 3000x2000 pixels
Image optimisation	Software use e.g. Paint Shop Pro, PhotoShop; type of manipulation (e.g. cropping, resizing)
Date of image optimisation	
Colour management system	E.g. ICC profiling undertaken within Photo Shop
Colour space	E.g. Adobe (1998) RGB
Image contributors	E.g. Photographer, scanner, editor
Image rights	E.g. HE & FE only

Figure 2: FILTER image creation log

Metadata Guidelines

Metadata is information attached to an image or resource in the form of keywords or free text. Metadata provides a range of information about a resource. This may be basic, such as its author, date of creation or subject content, for example, or more complex and difficult to summarise, such

as type of learning activity, level of difficulty of tasks. The information contained in metadata will be searchable and therefore aids the identification and retrieval of resources. Metadata is particularly important for visual resources that might otherwise stand alone without any text, and therefore be virtually irretrievable; users will depend on the information added to the image for accurate searching and retrieval (Rorvig, Turner and Moncada, 1999). The application of metadata is controlled by use of a schema containing defined fields for specific types of information. A great deal of research has gone into the development of the metadata schema for FILTER. The aim has been to balance the effective use of metadata with a process easily completed by authors that can also be monitored for quality (Day & Patel, 2002; Day & Richardson, 2002).

Guidelines on Selecting and Adding Metadata

This section includes a general discussion of metadata and its importance for the effective management and retrieval of electronic resources. Also included is a short tutorial on how to describe an image and how to select terms that will be most relevant to the intended audience. Authors are encouraged to use terms from a controlled vocabulary or thesauri in their subject area. A list of online vocabularies is provided together with examples of the vocabulary in use, where possible.

There are certain conventions for adding metadata in formats that are recognised by the FILTER database. For example, subject keywords must be separated by a semi-colon and must be lower case except where there is a valid reason for capitalising. Where terms from a controlled vocabulary are used, the name of the vocabulary must be placed in square brackets following the term, e.g. heart [MeSH]; heart disease [MeSH]; Picasso, Pablo [AAT]; computer-based assessment [ERIC].

Resource Metadata Schema

The following is the provisional FILTER resource schema, currently under development and likely to be amended following feedback from the initial round of dataset creators. All schemas in the generic image dataset are currently being tested by authors as they develop subject-specific datasets.

All schemas (image, resource, dataset and collection level) will contain an element that indicates the level of granularity of the object(s) being described. This is in order to facilitate the reusability of resources as, the more granular the object, the more reusable it becomes (Conole, Evans & Sims, 2002). The standard used for this description level is IMS, which currently defines four levels of granularity (IMS, 2001). Raw assets or data fragments, such as an image, are defined as possessing the highest degree of granularity, whereas an entire course would have the lowest granularity level.

The schema is based on the Dublin Core Metadata Element Set (Dublin Core Metadata Initiative, 1999) with the addition of several educational elements from the Draft Standard for Learning Object Metadata (LOM) specification developed by the IEEE [IEEE, 2001]. In order to facilitate the metadata submission process for authors and also, importantly, to ensure consistency and accuracy, FILTER is compiling vocabularies (or controlled lists) for use within specific metadata elements. This can be done where a finite list of terms can be predicted, for example: broad subject area, image type, resource type. These are presented to authors in the format of a drop down list from which a term, or terms, can be selected. Following discussion with FILTER authors, it was decided not to use the vocabularies suggested by LOM for use within educational elements. Authors felt that these vocabulary terms, being US-focused, were not appropriate or meaningful to UK and other audiences. FILTER is therefore working with the authors to create more relevant lists of terms that can be understood by the intended audience. This may lead to a certain loss of interoperability but authors strongly felt that it was more important that potential users should be able to understand terminologies used. Work being carried out by the UKOLN Metadata for Education Group (http://www.ukoln.ac.uk/metadata/education/) will be of relevance here in the future.

Element	Commentary
Resource Title (DC)	Short, meaningful title for the resource
Resource Creator (DC)	Author name and institute
Resource Subject, Broad (DC)	Broad subject category (e.g. History, Geography, Engineering). List provided by FILTER
Resource Subject (DC)	Multiple keywords selected by authors from a controlled vocabulary OR free text keywords of the author's choice OR a combination of both of these. Where terms from a controlled vocabulary are used, note the name of the vocabulary in square brackets
Resource Description (DC)	Free text description of the overall resource
Resource Language (DC)	Defaults to English
Resource Rights (DC)	Standard template description of resource copyright provided as default text by FILTER
Resource Audience (LOM)	The category of user for whom the resource is intended, supplied by FILTER
Resource Interactivity Type (LOM)	The type of interaction between the resource and the intended user, supplied by FILTER
Resource Interactivity Level (LOM)	The level of interaction between the resource and the intended user, supplied by FILTER
Learning Resource Type (LOM)	The specific kind of learning object, most dominant kind first, supplied by FILTER

Figure 3:FILTER schema for a teaching resource

The following table shows a list of resource "types" that FILTER has compiled to be used in the "Learning Resource Type" element (see Figure 3). The list has been based on existing vocabularies, such as those developed by the Scottish electronic Staff Development Library (SeSDL - http://www.sesdl.scotcit.ac.uk:8082/main.html), the Gateway to Educational Materials (GEM - http://www.geminfo.org/) and the Results project (http://results.csu.umist.ac.uk/), as well as suggestions from authors and other academics. This list is not intended to be static and authors are encouraged to suggest additional types.

FILTER Resource Types		
Animation	Experiment	Narrative text
Assessment task	FAQ	Practical/experiment
Bibliography	Figure	Problem statement
CAL package	Glossary	Question
Case study	Graph	Questionnaire
Dataset	Handout	Simulation
Diagnostic test	Lecture	Self assessment
Diagram	Lecture note	Slide
Essay	Lesson plan	Table
Exam	MCQ	Tutorial
Exercise	Model/simulation	

Figure 4: FILTER vocabulary for resource 'type'

Image Metadata Schema

The following is an example of a completed image metadata schema for the image below. The schema is based on Dublin Core with some FILTER-specific adaptations.

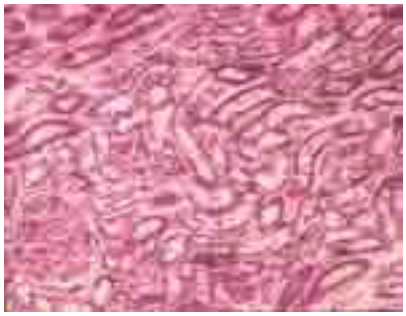

Image 1: Histology sample from the Bristol Biomedical Image Archive

Element	Commentary
Image Description (DC)	Histological haematoxylin and eosin stain of intrinsic renal failure in dog - dilated tubules some of which contain cellular debris
Image Donor (DC)	Dr Peter Brown, University of Bristol, Department of Pathology & Microbiology
Image Format File Size (DC qualifier)	626421 bytes
Image Format (DC)	image/jpeg
Image Owner (DC)	Bristol Biomedical Image Archive, University of Bristol
Image Publisher (DC)	
Image Rights (DC)	All images and resources in the FILTER database are protected by United Kingdom and international copyright laws and may not be used, other than for non-profit, educational purpose, without the express permission of FILTER.
Image Subject (DC)	kidney [MeSH]; kidney tubules [MeSH]; dilatation [MeSH]; kidney failure [MeSH]; dogs
Image Title (DC)	Dilated tubules in canine kidney failure
Image Type (DC)	Micrograph

Figure 5: Example of a completed image metadata schema for the preceding image

FILTER is compiling a list of image types in collaboration with authors and via results of an international online image categorisation exercise (Evans & Shabajee, 2002).

Dataset Metadata Schema and Collection Level Description
FILTER is currently developing a schema for dataset level description and investigating the use of the Research Support Libraries Programme (RSLP) Collection Description Schema (http://www.ukoln.ac.uk/metadata/rslp/schema/) for collection level description.

Conclusion

There are clearly numerous opportunities for the academic community to take advantage of the wealth of digital images that are available online for the purpose of resource creation. FILTER investigations indicate that there are still impediments to the uptake of this visual material, however, and it is still the case that in certain subject areas images are under-used, possibly because of a lack of understanding of the important role images can play in the support of learning, teaching and research. There is an obvious requirement for more practical guidance and instruction in using images effectively. FILTER's aim is to support and encourage potential users of digital images through the provision of effective and appropriate examples of image use in a range of pedagogical contexts.

There is great potential for the sharing and transference of knowledge from those subject areas that are proficient in image use to those where image use is not clearly understood. FILTER is encouraging users to look beyond their own subject areas so that they may discover new, creative usages of images in other disciplines and adapt these for their own teaching purposes. One of the main objectives of FILTER is to facilitate this cross-subject transference and sharing of knowledge and skills. A method of achieving this cross-fertilisation of knowledge is through the provision of a generic image dataset that has been developed to help members of the tertiary education community who would like to use - or increase their ability to use - digital images for learning and teaching. Users will be able to download and adapt the generic dataset in order to create subject-specific datasets.

The next stage of FILTER research is an investigation of innovative ways of representing datasets to encourage and support exploration of resources across subject domains. Finally, an extended period of evaluation will take place allowing an investigation of how resources are being reused. Evaluation will focus on determining how and for what purpose users are extracting and reusing dataset components, and reviewing the usefulness of FILTER metadata schemas in facilitating the discovery and reuse of granular learning objects. It will also be important to assess the impact that the resources will have on both academics, who may consider reviewing or adapting their teaching methods and the contexts in which teaching is delivered, and on learners, who may feel that informed use of images adds a new dimension to the learning process and enhances their understanding of topics. The results of this evaluation will be publicised in late 2003.

References

British Educational Communications and Technology Agency (Becta). (2002). *Computer games in education project.* [Online]. Available: http://www.becta.org.uk/technology/software/curriculum/computergames/index.html [26th September 2002].

Conole, G., Evans, J. & Sims, E. (2002). Use and reuse of digital images in teaching and learning. In A. Littlejohn (Ed.), *Reusing Resources for Networked Learning.* London: Kogan Page.

Day, M. & Patel, M. (2002). *Metadata for images: a report for the FILTER project.* Bath: UKOLN. [Online]. Available: http://www.ukoln.ac.uk/metadata/filter/report/ [26th September, 2002].

Day, M. and Richardson, H. (2002). FILTER metadata element sets for images and learning objects. Bath: UKOLN. [Online]. Available: http://www.ukoln.ac.uk/metadata/filter/schema/filter-metadata-10.doc [26th September 2002].

Dublin Core Metadata Initiative. (1999). *Dublin Core Metadata Element Set, Version 1.1*. DCMI. [Online]. Available: http://dublincore.org/ [26th September 2002].

Duchastel, P.C. & Waller, R. (1979). Pictorial illustrations in instructional texts. *Educational Technology, 19*(11), 20-25.

Evans, J. & Shabajee, P. (2002). Preliminary results of the FILTER image categorisation and description exercise. *DC-2002: Metadata for e-communities: supporting diversity and convergence. Florence, October, 13-17*.

Evans, J., Conole, G. & Youngs, K. (2001). FILTER: Focusing Images for Learning and Teaching – an Enriched Resource. *ASCILITE 2001, University of Melbourne, Australia, December 9-12*.

Grout, C. (2001). JISC Distributed Image Service: strategy, policy framework, service environment & implementation plans. London: The Joint Information Systems Committee. [Online]. Available: http://www.jisc.ac.uk/dner/images/imagespolicy.html [26th September 2002].

IEEE Learning Technology Standards Committee (LTSC). (2001). *Standard for Information Technology - Education and Training Systems - Learning Objects and Metadata*. LTSC. [Online]. Available: http://ltsc.ieee.org/wg12/ [26th September 2002].

IMS Global Learning Consortium, Inc. (2001). *IMS Learning Resource Meta-Data Information Model, Version 1.2.1 Final Specification.* IMS. [Online]. Available: http://imsproject.org/metadata/imsmdv1p2p1/imsmd_infov1p2p1.html [26th September 2002].

Kirriemuir, J. (2002). *The relevance of video games and gaming consoles to the Higher and Further Education learning experience*. London: The Joint Information Systems Committee.

[Online]. Available: http://www.jisc.ac.uk/techwatch/reports/tsw_02-01.rtf [26th September 2002].
Kress, G. and van Leeuwen, T. (1996). *Reading images: the grammar of visual design.* London: Routledge.
Levie, W. H. & Lentz, R. (1982). Effects of text illustrations: A review of research. *Educational Communication and Technology Journal*, 30(4), 195-232.
Levin, J. R. (1989). A transfer of appropriate processing perspective of pictures in prose. In H. Mandl & J.R. Levin (Eds.), *Knowledge acquisition from text and prose.* Amsterdam: Elsevier Science Publishers.
Mitchell, W.J.T. (1994). *Picture Theory: Essays on Visual and Verbal Representation.* Chicago and London: University of Chicago Press.
Paivio, A. (1971). *Imagery and Verbal Processes*. New York: Holt, Rinehart & Winston.
Paivio, A. (1975). Imagery and long-term memory. In A. Kennedy & A. Wilkes (Eds.), *Studies in long term memory* (pp.57-85). London: John Wiley & Sons.
Paivio, A, Rogers, T.B. & Smythe, P.C. (1968). Why are pictures easier to recall than words? *Psychonomic Science, 11*(4), 137-8.
Rorvig, M.E., Turner, C.H. and Moncada, J., (1999). The NASA image collection visual thesaurus. *Journal of the American Society for Information Science, 50* (9), 794-798.
Standing, L. (1973). Learning 10,000 pictures. *Quarterly Journal of Experimental Psychology*, *25*, 207-222.
Standing, L., Conezio, J. & Haber, R. N. (1970). Perception and memory for pictures: Single-trial learning of 2,500 visual stimuli. *Psychonomic Science, 19*(2), 73-74.
Williams, J., Lock, A., Crisp, J. & Longstaffe, A. (1995*). The use and capture of images for computer-based learning II.* AGOCG Technical Reports Series. [Online]. Available: http://www.agocg.ac.uk/reports/graphics/capture2/title.htm [26th September 2002].