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Improving Pedagogical Performance Through Multimedia Learning Systems

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Abstract

This paper reports the case study of the design of a web-based multimedia learning system, Eternal Egypt from a pedagogical perspective. An emerging trend in education has been the shift in focus from that of teaching to that of learning. The affordances of technologies, in particular instructional multimedia have aided the movement from teacher-centered, content delivery curricula design models to student-centered, constructivist paradigms of learning. Eternal Egypt is a multimedia information repository that showcases the rich art, history, people, places and religions of Egyptian civilization. Based upon established learning theories, both the strengths and limitations of this educational website will be analyzed to construct a better understanding of the heuristics of multimedia learning systems design.

Introduction

Undoubtedly, the capabilities of multimedia have added a new dimension to the processes of teaching and learning. Combining multiple modes of presentation, multimedia instructions have the potential to engender engaging, authentic learning environments. Integrating contextual information in a variety of formats such as textual, verbal and pictorial, multimedia instructions allow learners to manipulate the available information in interactive ways and aim at promoting reflection and critical thinking (Williams, 2004). Multimedia instructional products come in multiple formats such as commercial software packages, interactive videodisc packages and authoring tools. They can also be published as web page documents and have the capacity to optimize learning gains (Roblyer and Edwards, 2000).

Though multimedia learning has been used pervasively in the development of instructional materials, educational research on the effective design of effective multimedia learning systems has been scarce (Tabbers, Martens & Merrienboer, 2004). Two focal areas on multimedia research with promising results have been the work on cognitive load theory by Sweller (1999) and the experiments on multimedia learning by Mayer and his colleagues (2001).

In this article, drawing upon the findings of Mayer's work I explore from a pedagogical orientation some of the design features of a web-based open-source hypermedia instructional system, Eternal Egypt (www.eternalegypt.org). Eternal Egypt is an interactive digital space showcasing the rich art, history, people, places and religions of the five thousand year old Egyptian civilization.

Learner Control

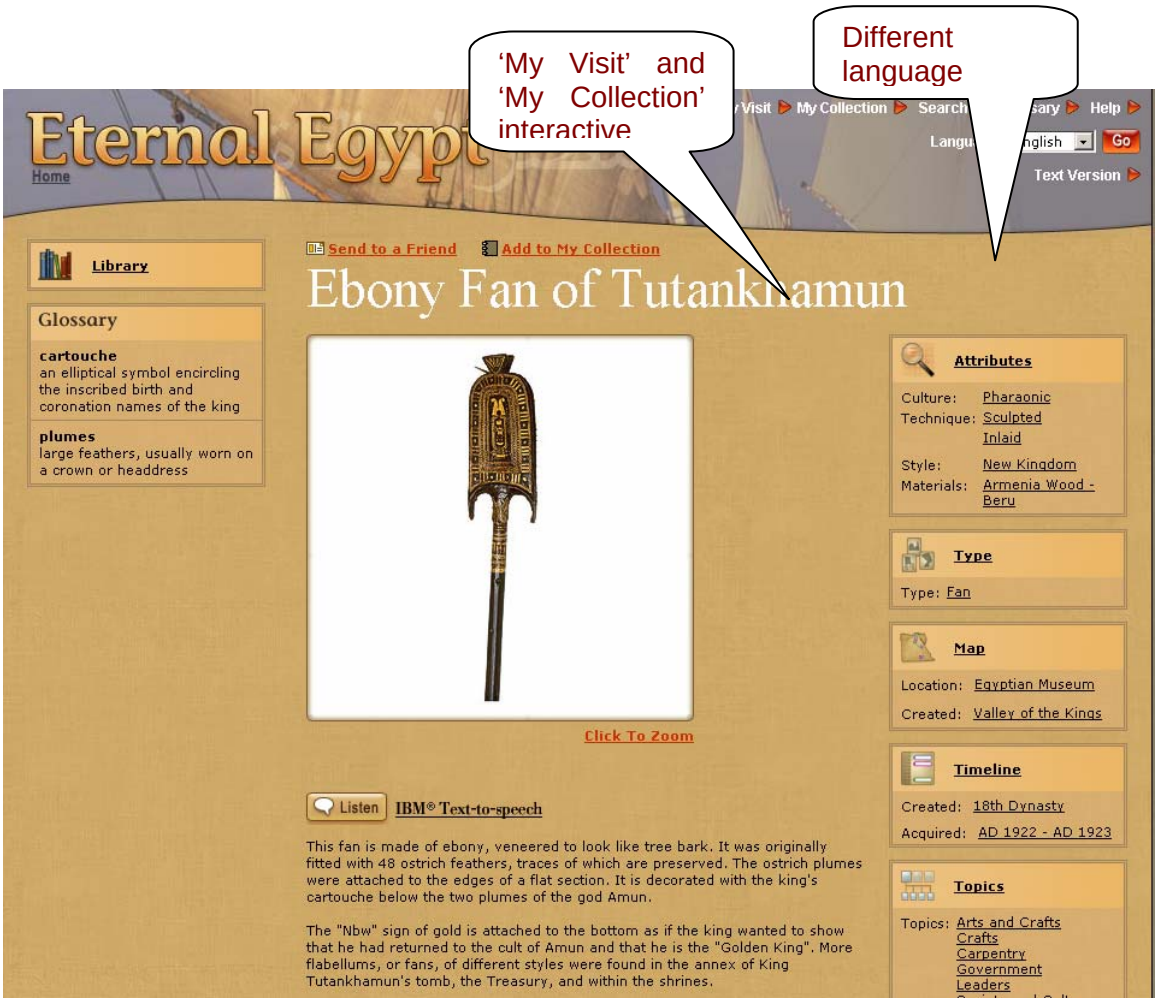
Learner control is one of the most deeply researched dimensions of hypermedia-based learning environments (Cheung & Lim, 2000). Williams (1997) defines learner control as instructional designs where learners make their own decisions regarding some aspect of path, flow or events of instruction. The most common type of learner control in hypermedia applications is control over the sequence of content that is presented and the pace at which these content can be accessed (Cheung, 1996). Since the information and activities presented within the hypermedia space are inter-connected by links in a non-linear fashion, learners have a wide range of navigation routes to traverse in charting their learning progress. This empowers users of the

hypermedia program to become independent and active learners. Provided that learners know which is the best path to take to account for their own learning, hypermedia learning systems situate learners in a better position to make effectual judgements about and monitor their own learning progress according to their levels of interest, prior knowledge, learning styles and other factors (Small & Grabowski, 1992). Some learners may start from the beginning and move on to complete the end of the hypermedia instructional content linearly and sequentially while others may leave an activity half-completed to explore another section before returning to complete the initial activity (Laurillard, 1993). Thus learners can choose learning activities that suit their individual preferences and needs (Williams, 1997).

Eternal Egypt is embedded with features that offer autonomy and flexibility to learners. Learners have the liberty to navigate their way through multiple paths in covering the online content. Thus learners are able to view content in alternative ways according to their preferences and comfort levels. However to be a self-regulated and successful learner who is able to choose the most effective route that optimizes his/her learning requires the learner to have a reasonably good level of meta-cognitive skills. These meta-cognitive abilities allow the learners to map out their learning trajectories, be aware of their own learning competencies, monitor their learning progress and be informed of the learning outcomes expected of their assigned instructional tasks. The same information presented in Ancient Egypt on an artifact can be accessed in multifarious ways through iconic representations such as its type, physical location as indicated on the digital map and its position on the timeline according to when it was created and acquired. Any one of these links can be used as the digital entry point to gather the same information on the artifact. There are choices even in the language medium to be used to access the online content of Eternal Egypt. The current version allows the learner to select the language option of either English, French or Arabic in viewing the information resources.

Learning doesn't happen in isolation nor is knowledge disembodied. Rather learning has to be situated in meaningful contexts which learners can relate to and make sense out of it. This helps learners to make connections with the new information that is presented and facilitate its integration in existing knowledge structures. Eternal Egypt has been thematically designed with the presented information being tied to meaningful contexts. Web pages communicating information on an artifact, have a portlet titled 'Connections' which when clicked sets one off on the chain journey of discovering how the artifact is related to a character, and in turn how the character is related to a place etc. Thus the learner gains a holistic overview of not only information on the artifact but also how it is inter-connected in complex yet fascinating ways with other items.

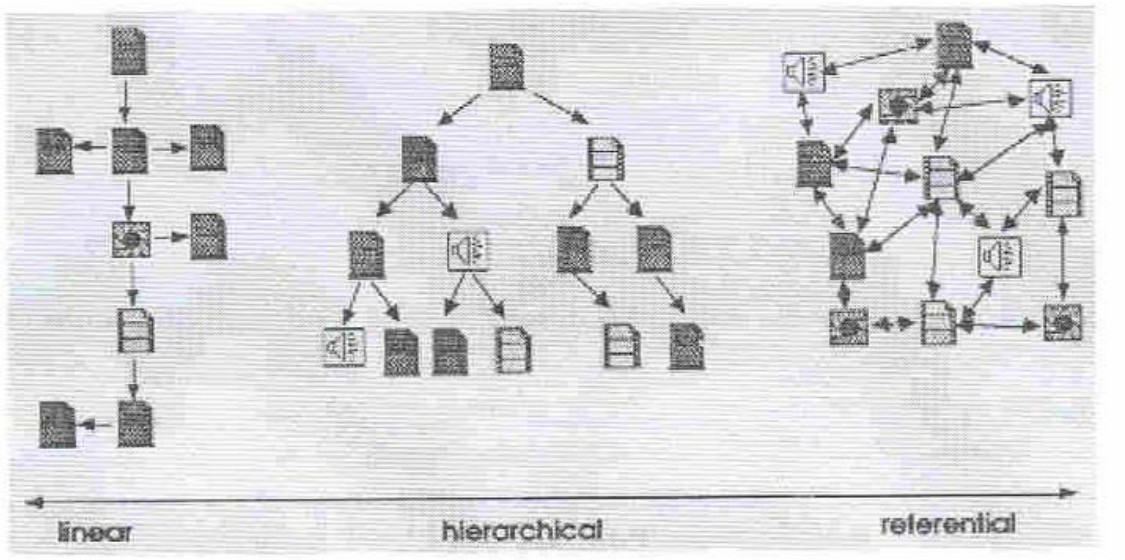
Figure 1: Learner control with different navigational routes (Reproduced with permission from Eternal Egypt)



Hypermedia Structure

Oliver and Herrington (1995) explicate a continuum that describes different forms of hypermedia systems and the nature of the links that connect their constituent nodes (web pages). At one end of the continuum, the links are minimal and connect the nodes in a linear, sequential fashion as would be found in turning the pages of conventional textbooks. In the middle of the continuum are hypermedia systems with links that are arranged in a hierarchical structure giving learners more freedom to navigate in the hypermedia terrain. At the other end of the continuum is hypermedia that provides a totally unstructured learning environment with multiple referential links between associated nodes.

Figure 2: A continuum describing linking in hypermedia (Adapted from Olver & Herrington, 1995)



Eternal Egypt offers a hypermedia environment which has a high degree of referential link structure where the nodes are inter-connected such that they allow learners to maneuver around flexibly and freely. Each of these thematic nodes are referentially and associatively linked to allow for seamless navigation through the vast information space of its website. Such links serve as cognitive supports to scaffold authentic learning. This facilitates learners to conveniently and easily locate and retrieve information they need. These links help to minimize cognitive overload which might otherwise be imposed if all these content had been cluttered on the same page. Learners can start of at any entry point of the website in their information quest and they then have the choice to move through any of the different paths that's available to them. Thus they manage their own learning strategies with a high degree of flexibility and interactivity. This is more so pertinent in the context of an open-sourced information website such as Eternal Egypt which isn't targeted towards a particular group of learners nor does it have a pre-defined set of learning objectives it hopes to achieve once the visit to the site is completed. Thus it would be cogent to assume that users who access the site would be coming from varying backgrounds with different levels of cognitive and meta-cognitive abilities. They would also have diverse learning outcomes they hope to realize upon completion of their website visit. So a less structured learning environment with fewer constraints in manoeuvring through the hyperspace of the website would model a more responsive and adaptive learning approach that matches the learning styles of the users. It engenders a learner-centered learning experience for the users.

Different Learning Styles

Various learning styles have been advanced in recent research on multimedia integrated learning environments. One set of learning styles is the do-then-learn versus learn-then-do styles (Carliner, 2002). The do-then-learn style facilitates people who prefer to 'do' first and then pick up the content through trial-and-error. Then they label the ideas covered and learn how to apply those concepts more broadly. The learn-then-do approach is for people for prefer to learn all they need to from the materials presented, then perform the task to reduce the likelihood of errors.

Another set of learning styles revolves around the predominant faculties through which learning takes place (Carliner, 2002). Some are verbal learners who learn best by reading and others are visual learners who learn best by hearing. Yet others might prefer a multi-sensory integrated approach to learning. Instructional designers of multimedia learning systems try to accommodate multiple learning styles by using a variety of presentation strategies. Since it wouldn't be feasible to offer varieties of learning styles for the entire content of a hypermedia program, instructional designers could account for these learning styles by presenting different sections of the content using multiple strategies. Thus over the course of a learning program, ideally most learners' style would have been addressed at least once (Carliner, 2002). This helps to support personalized learning by creating a zone of comfort for the users and facilitating their learning. Eternal Egypt's design allows those who prefer a more textual approach to learning to access the fully-text based version of the content. Those who desire a multimodal style of presentation can choose the version of the same content presented with a mix of graphics, audio, 3-D models and animations.

There are other personalized features offered by Ancient Egypt which serve as useful aids. The 'My Visit' tab when clicked lists the nodes (web pages) that have been visited by the learner. This enables the learners to monitor and keep track of the web pages they have accessed thus far in their search for information. The 'My Collection' feature allows the learners to collate virtually the digital items in Eternal Egypt which are of interest and utility to them.

Many interactive features have also been integrated into Eternal Egypt. The ability to rotate, zoom and view 3-D models allow the learner to perform spatial manipulations and study the artifact from different angles. There is also an interactive timeline which allows the learner to cognitively conceptualize the chronological context of landmark stories, artifacts, characters, and places of Egyptian culture. Such a multimodal and responsive representation of the history of Egypt provides a more stimulating and engaging learning experience for the user.

Limitations and Possible Design Improvements

Interface designs that have not been well-planned can impose an extraneous mental and cognitive load on the learners to get familiarized with the features and functions of the hypermedia system. This could potentially distract the learners from the learning activity. This is due to the fact that learners are compelled to think and consider how an interface operates when undertaking a learning task, their attention is split and the mental effort required to attend to information from multiple sources lessens that which can be applied to the actual learning task (Chandler & Sweller, 1991). This is tied to the phenomena of orientation in navigation through hypermedia systems. Orientation describes the means by which users are able to identify their current position in the system, how they achieved that position and how to return to a previous position (Oliver & Herrington, 1995). Disorientation is a problem which is frequently observed in studies of hypermedia users and a problem which significantly limits instructional outcomes (Collins, 1991).

Eternal Egypt is a large online repository containing a wealth of information resources which have been built around a flexible net structure consisting of multiple referential links between these resources. There is every possibility of a learner finding himself/herself lost in the digital space of Eternal Egypt. This is further compounded by the fact that the location of the item portlets changes between

screen shifts. It would be preferable from an instructional design viewpoint to keep the design features consistent in every page with the only things changing being the information input. Furthermore incorporating a simple enhancement in Eternal Egypt such to graphically indicate on a site map the user's current position within the net structure would be of significant assistance to learners (Oliver & Herrington, 1995).

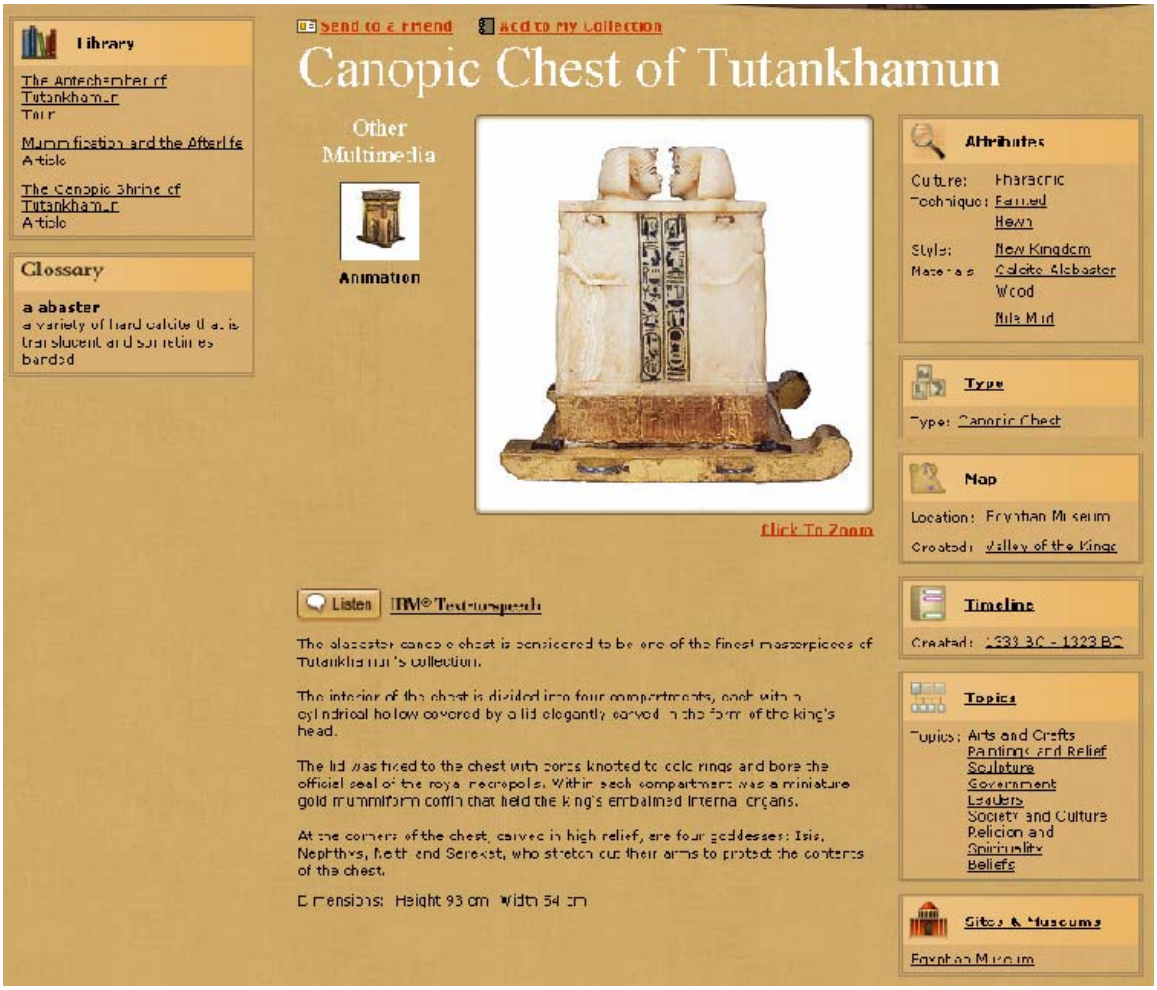
Figures 3: Inconsistency in design layout (Reproduced with permission from Eternal Egypt)

Contiguity Principle

Contiguity Principle is one effective design guideline that could be applied in the development of multimedia instructional courseware. It recommends that corresponding graphics and printed words be placed near each other on the screen i.e contiguous in space (Clark & Mayer, 2003). This principle has been violated in

Eternal Egypt where the visuals and explanatory text are separated, one before the other with the text being partially obscured due to scrolling screens. This exerts extra cognitive load on the learner who needs to scroll up and down the screen to connect the instructional content to the graphics. Provided that audio explanations haven't been built-in, a suggested change to the presentation layout would be to reduce the size of the graphics and place it next to text on the scrolling screen. In the event that audio narrations for the text are made available as is currently in Eternal Egypt, then the application of Redundancy Principle as explained in the following section supersedes that of Contiguity Principle.

Figure 4: Non-conformity to Contiguity and Redundancy Principles (Reproduced with permission from Eternal Egypt)



Redundancy Principle

Redundancy Principle is another rule based on cognitive psychology that can be applied in the design of multimedia learning content. It argues that graphics explained by audio alone rather than graphics explained by audio and redundant onscreen text gets better learning results (Clark & Mayer, 2003). Both the graphics and redundant text would compete for the limited resources of the visual channel of the working memory. Thus the advantage of presenting words in audio alone is that one avoids overloading the visual channel. This principle has been overlooked in the design of Eternal Egypt. Both the printed text and audio narration of the text have

been simultaneously presented on-screen which could unnecessarily tax limited cognitive resources of the visual channel working memory. It would be better as outlined by Redundancy Principle to use graphics and audio narration alone.

Conclusion

Developing multimedia environments according to established learning principles founded on research findings is important. This will ensure that productive learning takes place with ample opportunities being presented to learners to think contextually, analytically and reflectively. An effective design of a multimedia instructional environment both models and mediates the learning processes taking place in the cognitive architecture of learners. In the process, students appropriate new knowledge through active engagement with the interactive elements embedded in the multimedia environment. Unlike traditional notions of education involving acquisition knowledge, multimedia learning environments have the capacity to function as tools with instrumental value in organizing knowledge schemas that could be applied to accomplish a variety of tasks. In this paper, through the case study of Eternal Egypt I have expounded on a number of critical instructional design issues that need to be considered in the development of pedagogically-sound multimedia instructional systems

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