USING WIKIS AS A TEACHING AND LEARNING RESOURCE

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ABSTRACT
Wikis represent the next natural and logical development in the 'history of writing'. They were first introduced over 10 years ago as a fully editable writing tool to facilitate collaboration through the use of networked computer systems. Since their introduction by Ward Cunningham in 1994, wikis have been used for a variety of teaching and learning applications. This paper outlines and illustrates some of the attractive features of the wiki genre of software as tools for the creation and management of electronic knowledge within the context of the teaching and learning activities that take place within a higher-education environment.

KEYWORDS
Electronic writing, collaborative writing, webs, weblogs, wikis, wiki engines, electronic learning, knowledge representation, knowledge management

INTRODUCTION

Knowledge and information have a vital role to play as assets that facilitate human problem-solving activity. It is of interest therefore to speculate on how and from where these two resources originate. There are a number of possibilities. For example, data, information and 'raw' knowledge can be derived from various observational processes that people undertake. An observational process can be regarded as a communicative event in which a particular object or process reveals some information or data about itself to an observer who is interested in obtaining it. As a result of this, the observer becomes more knowledgeable about the entity being observed. Another important source of knowledge is the thought processes that take place within the human mind. For example, a person might take two facts arising from an observation and use these to derive or deduce new knowledge that previously had not existed. A third source of knowledge is from other people. However, this latter source depends, probably more so than the others, on an individual's ability to communicate with other people. It also depends on the availability of an appropriate common framework within which to represent knowledge. Inherent in this requirement is the need for some form of language or linguistic notation. This is necessary both for the representation of ideas and for their communication to other people.

Language and communication are therefore a fundamental part of the processes involved in acquiring, storing and sharing data, information and knowledge. Again, it is interesting to speculate on how language and systems of communication have emerged - particularly, those involving the process of writing. Undoubtedly, the most primitive forms of human communication are essentially tactile in nature. Indeed, within its life-cycle, the very first form of communication used by a human-being is essentially tactile - think of a kicking baby inside its mother's womb. However, this form of communication has only a limited audience. At birth, the mode of communication changes. It becomes both sonic and gesticulatory. The crying and frantic movement of a baby's limbs as it emerges from its mother's womb is evidence of this. The sounds made by a baby are therefore reinforced by the gesticulations of its arms and legs - a truly 'multimodal' (or multimedia) approach to communication. The baby kicks its legs and waves its arms - either because it is in pain or through the excitement of being born. Eventually, babies learn to smile - another communicative event that reflects (to observers)

an internal state of well-being. Later in their lives, children learn to speak, dance, sing, compose music, recite poems and write. From then on in, they become avid communicators on their mobile phones - using both spoken utterances and text messages.

Although it is only one of many different modes of communication, writing (which, for this discussion also includes drawing) has a special significance because (in bygone days) it provided us with one of the first tangible means of extending our minds through the external representation of knowledge. Of course, many other methods also began to coexist in order to facilitate this need: doodling, etching, sketching, painting, model building, and so on. However, because it has a special relevance to subsequent parts of this paper, it would be worthwhile briefly recounting the 'history of writing'.

As was suggested above, humans probably used sonic effects (grunts, groans, and various other forms of sound) prior to embarking upon the use of written symbolisms for communication. However, before the advent of sound recorders, the limitations of spoken utterances were their short-livedness, and hence, people's inability to remember them. At their inception, the power of written symbolisms therefore lay in their potential longevity. Once an idea had been committed to a suitable writing medium, there was a chance it could achieve immortality. Furthermore, there was also the possibility that it could be communicated to people other than just those present in one's immediate vicinity.

Naturally, the success of a writing process depends very much upon the nature of the medium that is used to record it. Early writers attempted to make marks in the sand with their fingers. Because this was ultimately a painful way to write, they soon turned to using sticks (and various other implements) in order to scribe their markings. But, there was another problem; the effects of wind, rain and (possibly) the sea made their writings almost as transient as speech. So, another more durable medium was needed. During our historical evolution we have tried, in turn, cave walls, clay, stone tablets, papyrus, wood, metal and, of course, paper. Some of these media have required the creation of an appropriate 'marking fluid'. Of course, paper is now probably one of the most popular media for the support of writing processes - be these manual (using a pen or pencil), mechanised (based on the use of a typewriter) or automated (through the use of a printing press or a computer system). Naturally, the advent of computers has meant that 'electronic writing' now competes very strongly with conventional paper-based writing. The term *electronic writing* is used to describe the process of creating documents, and other artefacts, that reside (in electronic form) somewhere within the memory space of a computer or are located at one or more points within a computer network system - such as the World Wide Web. Such documents would normally be viewed through some form of electronic display system - such as a computer screen, a PDA or a mobile phone.

Compared with paper documents, electronic artefacts offer many attractive features - such as interactivity, adaptability, global availability, durability, collaborative development, ease of updating and certain levels of in-built intelligence. Of equal importance is the fact that many different types (or 'genres') of document are possible (Barker, 2005). For example, electronic books, static web pages, dynamic web pages, hypertexts, weblogs, wikis, and so on. In order to see how these different types of document have arisen, we need to consider the (relatively short) 'history of electronic writing'!

In a nut-shell, electronic writing started with the advent of the stand-alone 'word-processing' (WP) system. Compared with a typewriter, this facility enabled considerable levels of automation to be introduced into writing processes - through the use of templates, style sheets, macros, and the like. The next step forward came with the introduction of networked WP systems: first, through local area networks and then, second, through global communication networks. Such developments have meant that people anywhere in the world (that have the required connectivity) can collaborate with each other in order to produce shared documents. This development paved the way for the subsequent emergence of web sites, weblogs and wikis!

As suggested above, there are currently three basic types of globally shareable electronic document. First, there is the conventional web site - that is produced by an individual (or a team of people) for

'consumption' by others. Second, there is the weblog; this is a special type of web site that an author creates and, to which, other people may add comments (Clyde, 2004; Barker, 2005a; 2005b). Third, is the type of web-based document that is authored by many different people and which can be changed (added to and updated) by anybody who is allowed to access it; this is essentially the purpose of the wiki genre of software (Klobas, 2006; Ebersbach, Glaser and Heigl, 2006; Barker, 2007a).

Wikis are important because they provide a mechanism both for personal knowledge storage and, perhaps more importantly, a framework for the collaborative development of a knowledge corpus on some particular topic. The way in which a wiki is organised is illustrated schematically in Figure 1.

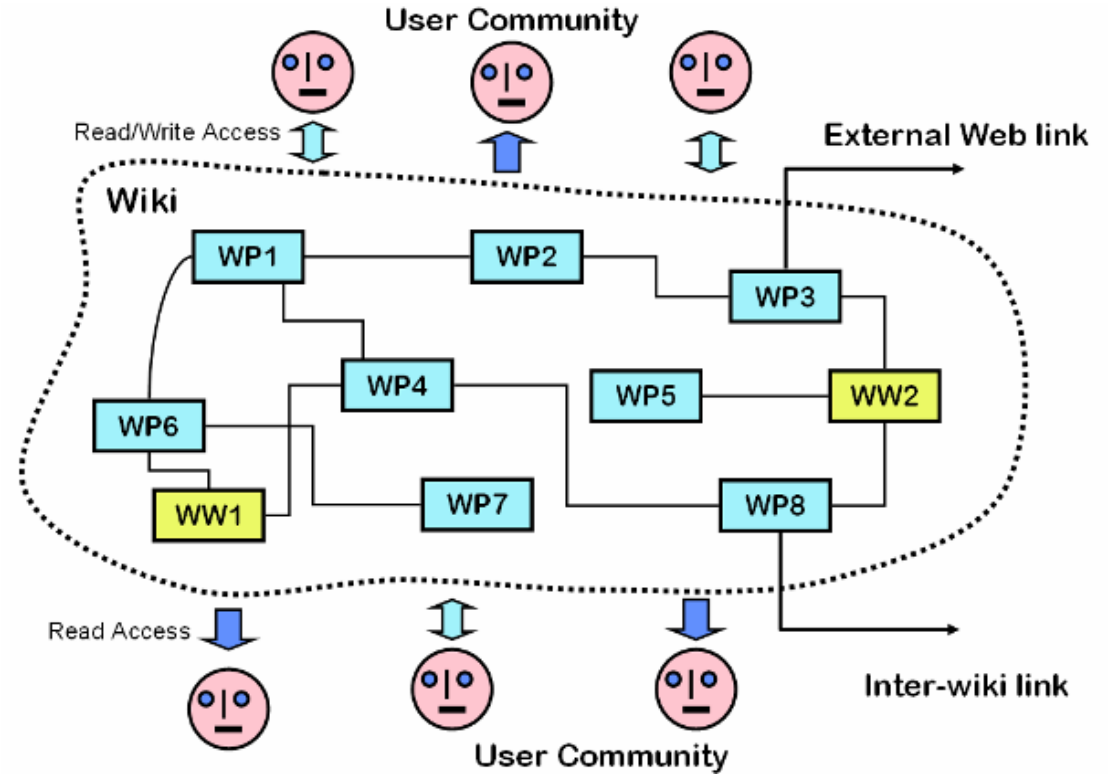

Figure 1. The basic structure and functions of a wiki system.

This is intended to portray a wiki as an interconnected collection of fully editable web pages (denoted by the labels WP_1 through WP_n) that could also embed further wiki webs (as indicated by the labels WW_1 through WW_n). The arrows depicted in this diagram represent the ability, on the part of a user, to create, read and/or modify selected pages within the structure. How these functions map onto individual user-capabilities will depend upon the access rights assigned to these users. Of course, there may also be pages within the wiki that are 'hidden' from ordinary users; such pages are normally associated with the various administrative processes associated with running a wiki and would usually only be seen by those who have 'admin' rights.

The main thrust of this paper is concerned with the use of wikis for storing different types of knowledge which can subsequently be used to support teaching and learning activities. However, before doing this, it is important to 'set the scene' by considering the general problem of knowledge representation and some of the computer-based approaches that have been used to accomplish it; this is an issue which is considered in the following section.

KNOWLEDGE REPRESENTATION

When considering the topic of knowledge representation and its management, there are two broad perspectives that need to be covered. First, the ways in which these processes are handled within the human mind; and second, the mechanisms that are used for processing knowledge that is external to this 'organic' stock. We have discussed some of the issues involved in the former situation in a previous contribution to the CBLIS conference series (Barker and van Schaik, 1999). In this paper, we shall therefore concentrate on the second of the two perspectives listed above.

An important and well-established mechanism for representing knowledge is through the graphical technique of concept mapping (McAleese, 1994). In some early work that we undertook, we used this approach to design and develop interactive graphical user interfaces to various electronic knowledge corpora (Barker and Proud, 1987). The types of (electronic) knowledge representation that we generated using our approach are illustrated schematically in Figure 2. Of course, it is important to emphasise the level of isomorphism that exists between the structures depicted in this diagram and those depicted in Figure 1. In order to create and access knowledge structures of the type shown in Figure 2, we had to design and create a software interface which we called the '*Graphical Knowledge Navigator*' (***GKN***). Figure 3 presents an example of a typical screen-shot that depicts the use of the ***GKN*** facility for creating knowledge structures of the type depicted in Figure 2.

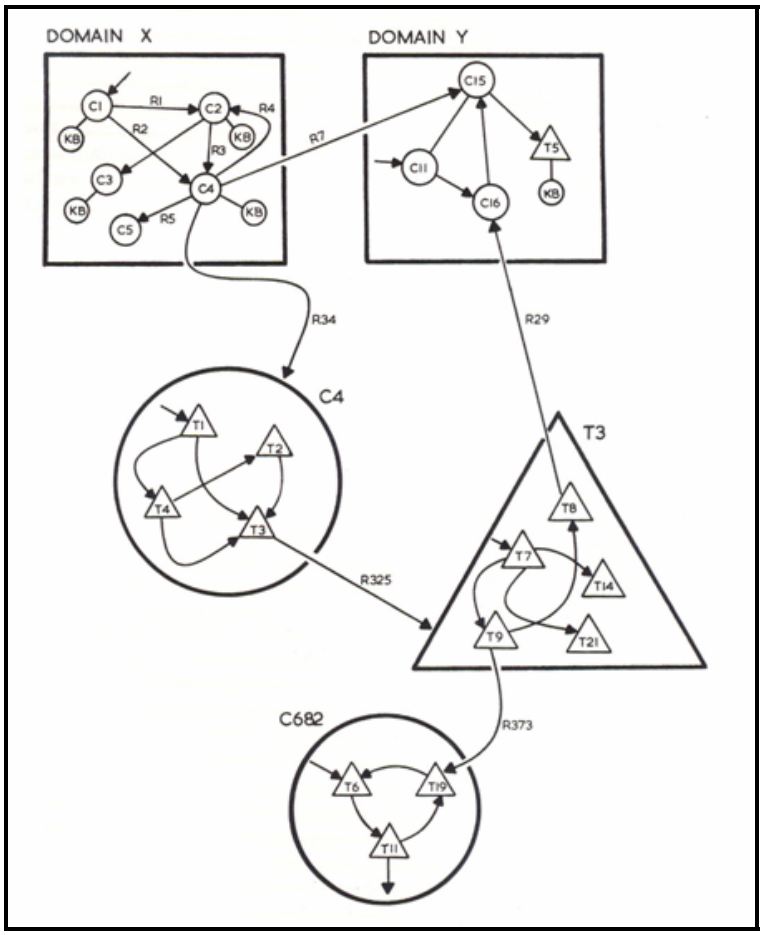

Figure 2. Graphical approach to knowledge representation used in the *GKN*.

Although it was very useful as a research tool, a major limitation of ***GKN*** was its essentially stand-alone nature. Indeed, it provided a very useful facility for representing personal knowledge collections in a localised context. However, technical limitations imposed on us (some twenty years ago) meant that stored knowledge could not be made globally available to its originator or shared with others. Of

course, the advent of the Internet, the World Wide Web and other forms of global connectivity means that such limitations have now been removed. Therefore, many new tools have become available for creating and sharing electronic knowledge. Some of the most important of these are web pages, weblogs and wikis. The ways in which wiki webs may be used, and techniques for creating them are discussed in subsequent sections of this paper.

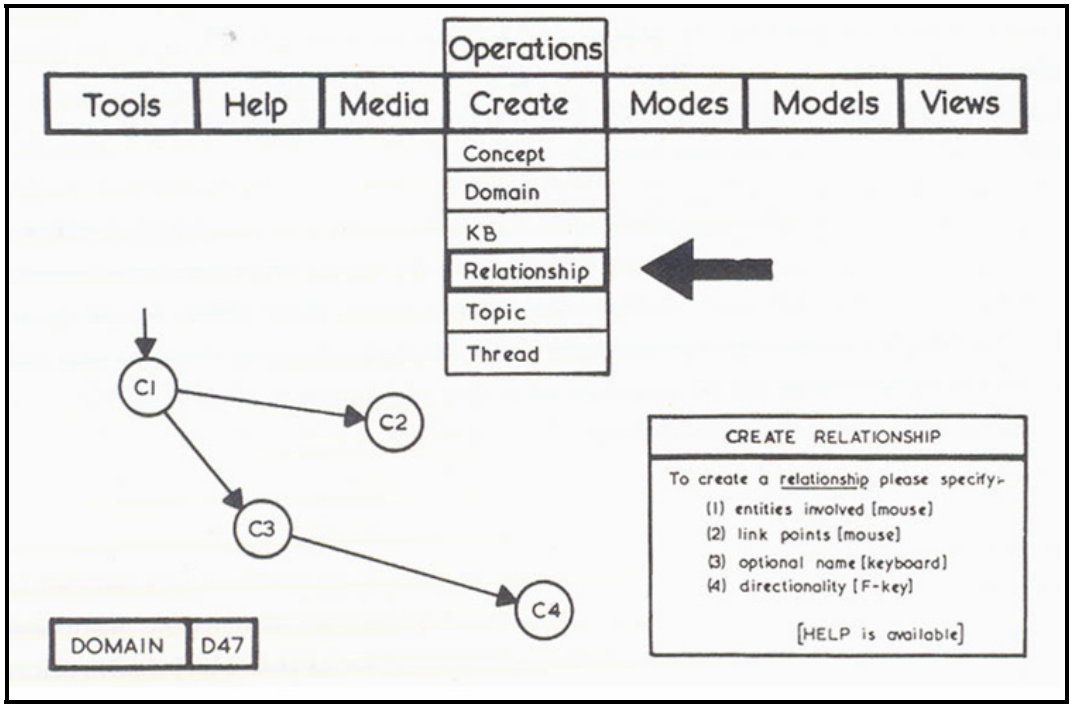

Figure 3. Using the *GKN* to create electronic knowledge structures.

WIKI SYSTEMS

When discussing wiki systems, there are four important issues that need to be considered. First, it is necessary to understand from where they have originated and why they have arisen. Second, we must consider how to define them. Third, we need to consider how to create and maintain them. Finally, we need to think about how to employ them and the purposes for which they can be used. These issues are addressed in this and the following sections of the paper.

The Origin of and Need for Wikis

It is claimed that wikis were first introduced as a collaborative writing environment in the early 90s by Ward Cunningham (Leuf and Cunningham, 2001; Augar et al, 2006). In many ways, wikis have emerged as a natural step in the evolution of 'social software'; that is, software that allows people to communicate with each other and collaborate through the creation of virtual online communities. This is therefore a natural progression from electronic mail through conferencing systems to weblogs and wikis. Of course, the major attraction of wikis (compared to weblogs) is their ability to allow balanced multiple authoring and shared access to a knowledge corpus in both a *documentation* mode and a *threaded discussion* mode.

Defining Wikis

In Figure 1 we presented a graphical representation of a wiki system. While this approach is quite a useful one for projecting the nature of a wiki, it is not particularly helpful for representing many of the properties of wikis. Furthermore, because Figure 1 is so specific, a more generic approach is needed. Because of this, we frequently need to have a more formal definition of exactly what a wiki is. One approach to defining a wiki in this way is illustrated in the following few lines of metanotation:

<wiki> ::= <node-set> + <link-set> + <link-mapping> + <properties>

<node-set> ::= [<node>]{1:N}
<link-set> ::= [<link>]{1:P}
<link-mapping> ::= [<source-node><target-node>]{1:Q}
<properties> ::= <end-user-interface> + [<functions>]{1:W}
<link> ::= <intra-wiki-link> | <inter-wiki-link> | <external-link>
<node> ::= <RO-node> | <RW-node> | <hidden-node> | <wiki-web-node>
<wiki-web-node> ::= <wiki>

In the above notation, the abbreviations **RO** and **RW** denote 'read-only' and 'read-write' capabilities, respectively. Thus, RO wiki pages can only be read while RW pages can be both read and written to. Naturally, these access capabilities would normally map (individually) onto the various members of the wiki's user community. Although they are not further discussed in this paper, the nature of the *<function>*s provided by a wiki and its *<end-user-interface>* also need to be defined. Another important issue that needs to be addressed is the characteristics of the various *<node>*s that make up a wiki. Because of its importance in relation to the different types of knowledge that a wiki embeds (for example, textual, graphical, executable, and so on) the *<mediality>* property of nodes needs to be introduced. In order to utilise this property, the definition of *<node>* that was given above would need to be modified in the following way:

<node> ::= <node-type> + <node-content> + <node-history>
<node-type> ::= <RO-node> | <RW-node> | <hidden-node> | <wiki-web-node>
<node-content> ::= <monomedia-node> | <multimedia-node>
<monomedia-node> ::= <text-node> | <graphic-node> | <audio-node>
<multimedia-node> ::= <text-part>+<graphic-part>+<audio-part>
<node-history> ::= [<version(I)>]{I=1,N}# + [<amendment(J)>]{J=1,M}#

In the fifth line of the above amended definition, an optionality operator needs to be introduced in order to describe the various blends of knowledge that a node might contain. Of course, the history of the knowledge nodes in a wiki web would also be another important property to consider - as this defines how a given page has evolved. These more involved issues of wiki definition are discussed in more detail in another paper (Barker, 2007a)

Wiki Wanderings - Explorations of some Currently Available Engines

In order to create a wiki two basic approaches could be used: either the software code that is needed is hand-coded using a suitable programming language or, alternatively, a 'wiki engine' is employed. A wiki engine is a generic piece of software that can be used to generate wiki webs - and provide all the infrastructure that is needed in order to maintain and administer it. Currently, there are numerous examples of such tools. This section briefly discusses some of the ones that I have explored during the research I undertook for this paper.

JotSpot - Early Experiences

My first real practical introduction to wikis arose as a result of my involvement with a conference on blended learning organised by the University of Hertfordshire in the UK. They organised a conference wiki using the *JotSpot* system. I used this environment in order to make my first attempts at both creating and defining a multimedia wiki. Various types of wiki based on the use of pictures, sound and moving images were introduced. This work can be found at the following Web address: *http://bluconference.jot.com/WikiHome*. *JotSpot* has recently been acquired by *Google* - see *http://www.jotspot.com*.

MediaWiki - WikiTravel Experiments

This is quite a useful and popular engine and is the underlying software used by the famous *Wikipedia* encyclopaedia project (*http://en.wikipedia.org/wiki/*) and other products from the Wikimedia Foundation - such as *WikiTravel* and *WikiNews*. I undertook an extensive study of this system and used it to make a *WikiTravel* entry on 'Walking and Rambling' for the town of Middlesbrough in the UK.

This can be found at the following Web address: *http://wikitravel.org/en/Middlesbrough* (entry 5.1.4). I often use this site as a 'teaching example' with my students as it shows to good effect the tremendous potential of hyper-linking within reactive electronic documents. Registered users of, and contributors to a wiki system can each have their own wiki page where they can present some information about themselves - see, for example, my entry in *WikiTravel*: *http://wikitravel.org/en/User:Barker_pg*.

Sakai - A Trip to Hawaii
This is another powerful system for wiki production. It is currently being employed by the UK's Teaching and Learning Research Programme as a resource within its *Virtual Research Environment*. I used this system to keep a record of the events and happenings (including an earthquake) that took place during a recent trip that I made to Honolulu in order to attend the *E-LEARN 2006 World Conference on Electronic Learning*. The pages of the wiki have links that are labelled 'Previous Page', 'Next Page', 'Home', and so on. This enables them to be read (and navigated through) like the pages of a conventional book. There is also a '*FunkyDunky*' page which acts like a personal sandbox area in which exploratory work can be conducted. This wiki can be found at the following Web address: *http://groups.tlrp.org/portal* .

TWiki - the 'King of Wikis'
In their book, Ebersbach, Glaser and Heigl (2006, p147) refer to TWiki as '*the flagship of the wiki variants*'. They describe it in this way because of the rich repertoire of facilities that it makes available. Included amongst these are: the ability to create multiple webs, its powerful search facility based on RegEx (regular expressions), RSS feeds, the ability to use JavaScript to enable 'executable knowledge' and its extensibility through the use of plugins. Skins and templates can also be used in various ways to change the appearance of a target wiki and control the embedded facilities that it makes available. I have been using this system to create a prototype 'Wiki for Walkers'. Further details of this system are available at the following URL: *http://TWiki.org/cgi-bin/view/Sandbox/WikiForWalkers*.

MoinMoin - on the Desktop
A desktop wiki is one which runs simply as a desktop application on a personal computer. It does not need any form of web server (other than an emulation of one) or any complicated administration set ups - it just functions on the desktop of the user that installs it (Wieduwilt, 2006). One useful example of a desktop wiki is *MoinMoin*. This can be downloaded from the following Web site:

http://MoinMoin.wikiwikiweb.de/DesktopEdition

It takes only minutes to install. I used the Windows version of this software as a learning tool to find out more about the way in which wikis work and the types of facility that they provide. I found this system to be a very useful learning tool. Indeed, it was used as a resource within the first vignette that is described in the 'Wikis in Education' section of the paper.

TiddlyWiki
The TiddlyWiki system is quite an interesting wiki facility that I have found to be very useful for building wikis for 'personal use'. It is available for download from the Web at the following URL: *http://www.tiddlywiki.com*. A 'student version' of the system is also available for download (see *http://checkettsweb.com/tw/tiddlywikise.htm*). This is a standard environment that has been 'tailored' in order to help students manage their lecture notes. This system was also used with students in the first vignette described in the following section of the paper.

TiddlyWiki is essentially a single HTML file (containing JavaScript) that behaves as though it was a computer programme. Because of its small size it easily fits onto a USB memory stick, and so, can be used to make personal wikis that are highly portable. Indeed, I have been using this system in order to explore its potential for supporting the development of a 'personal, portable knowledge management system'. The screen dump presented in Figure 4 illustrates the entry point into a newly created wiki for a particular subject domain that is held on a USB memory stick.

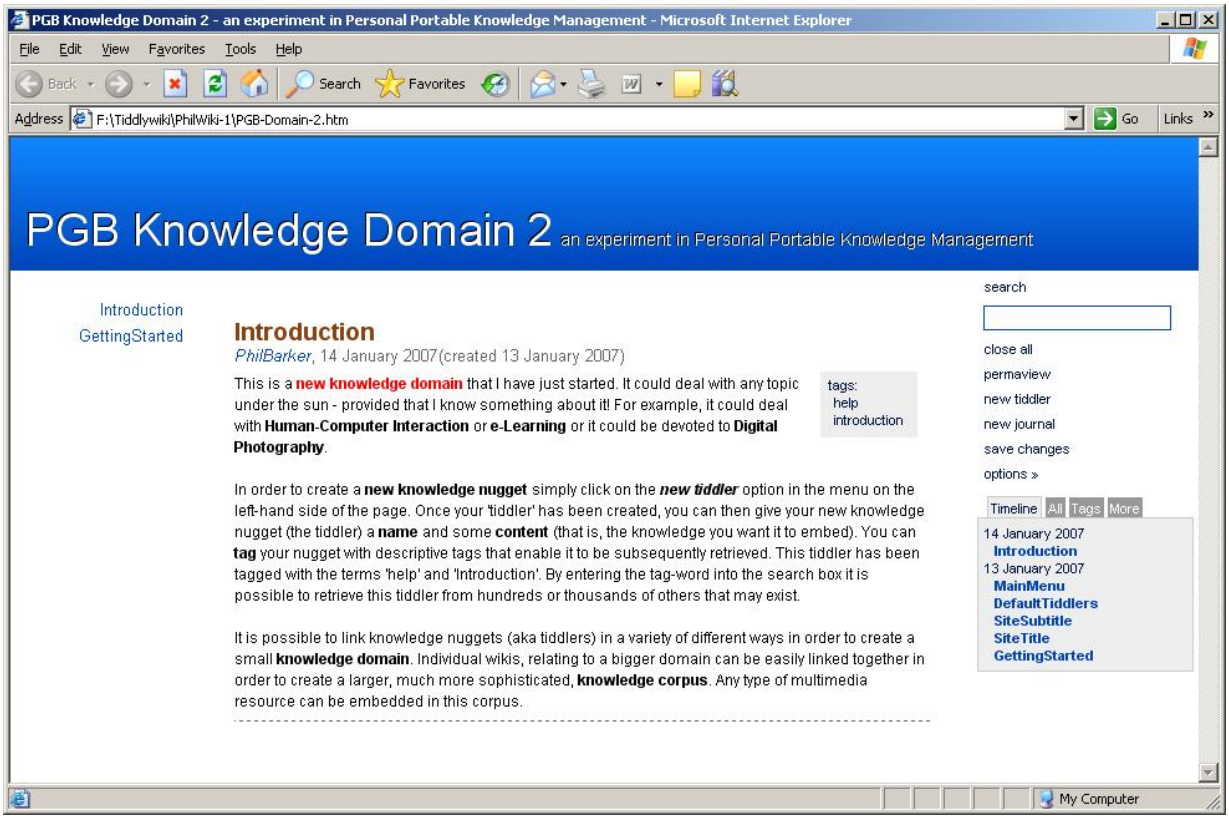

Figure 4. Use of the TiddlyWiki system for personal knowledge management.

The 'personal' version of TiddlyWiki does not need to be installed on a server and runs with virtually any browser - I am currently using both *Firefox* and *Internet Explorer* (Versions 6 and 7). From a knowledge representation perspective, TiddlyWiki enables knowledge nuggets to be stored in terms of primitive entities called '*tiddlers*'. These can be easily created using a built-in macro call to the '*new tiddler*' tool. New tiddlers (and existing ones too) can then be edited and, if required, tagged - in order to facilitate their subsequent retrieval using the system's built-in search engine. Essentially, a personal wiki consists of a collection of tiddlers and support tools (macros and plugins) that are relevant to any particular knowledge management application. Because TiddlyWiki is a small, compact, versatile and flexible system, it is a very useful tool for building ontologies for personal collections of e-knowledge that reside on portable (or fixed) e-storage devices,

Blackboard - the 'Teams Site'

Within both the academic and commercial arenas, the Blackboard virtual learning environment (VLE) has quite a popular following. Quite recently, this VLE acquired some extra functionality (in the form of weblogs and wikis) through the addition of its *Journal* and *Teams site* functionalities, respectively. The virtues of the *Teams LX* software (that Blackboard embeds) have recently been extolled by Dron (2006) who has written:

'*For those tied to Blackboard and wanting a safe, authenticated, no-hassle, low-threshold private wiki ... that incorporates an extremely easy-to-use WYSIWYG wiki called Teams LX. Full support for pictures etc. It even integrates into the assessment tools provided by Blackboard, allowing the instructor to view individual contributions and feed marks back automatically. You're not limited to a single wiki: you can create as many instances as you like within a given course as easily as you would create a static content page, so it's great for group work, collaboratively writing lecture notes (in class if you wish), reading lists and so on ...*'

The Blackboard wiki facilities were used in each of the two vignettes that are described later in the paper.

Choosing a System

There are quite a lot of wiki engines available - both commercial products and freely downloadable systems from the Web. Bearing in mind the variety that exists, choosing the most suitable one for any given project is quite a difficult task. In order to help overcome this problem, Ebersbach, Glaser and Heigl (2006, p260) provide some useful guidelines. They consider the following twelve key factors: programming language (such as Perl, Python or PHP), system requirements, technical capacity, installation effort, user administration, division into sections, expansion through the use of plugins, interfaces, convenient operation, language, documentation and further development.

WIKIS IN EDUCATION

Wikis are now being used within all levels of education and within virtually all areas of the curriculum. They are also being used to support a tremendous range of social activities. Some examples of their use within a higher-education context have been given by Augar et al (2006), Mitchell and Stansfield (2006) and Rheingold (2006). Each approach homes in on a different perspective of wiki work. In their research, Augar et al studied the use of a wiki for building a virtual learning community. They describe a pilot study that they conducted (at Deakin University) in order to explore the usefulness of a wiki for implementing an icebreaker activity for an online course dealing with Science and Information Technology. In their project, Mitchell and Stansfield (two students working at Leeds Metropolitan University in the UK) wanted to use a wiki to try to help first-year students overcome some of the problems that they face when they come to university. The authors state that: "*one thing we felt would provide real success was that students could find their own uses for it. ... finding their way around, where are the best places to get things, where should we go, who should we see about a specific issue. ... It's a fantastic place for people to share information altogether*". These researchers intend to make their 'student wiki' available to all students throughout the UK in 2007. The use of wikis, as described by Howard Rheingold, is part of a more general study into '*participatory media literacy*'. He uses a wiki generator called 'Socialtext' (*http://socialtext.com*) for the realisation of his research. As well as describing some uses of wikis for exploring online publication and learning in 'classroom' situations, his site contains a very useful section that which deals with the general pedagogical potential of wikis.

Our own work on wikis in a teaching and learning context has followed some less-usual pathways - as well as the normal ones (involving their use as collaborative and creative writing aids). These are described in the two vignettes that make up the remainder of this section.

Vignettes

The two vignettes described in this section of the paper are essentially summary descriptions of two more-in-depth case studies that the author has undertaken into the utility of wiki software as a teaching and learning resource

Wikis in the Teaching of HCI

An important aspect of the study of human-computer interaction (HCI) involves characterising those 'computer artefacts' that have an important impact on the human mind and, subsequently, human behaviour. Wikis provide one example of such artefacts - Web sites (in general), weblogs, computer conferences, electronic mail, and so on, are examples of others. Students of HCI are therefore required to study these, identify their structures, characteristics, content and behaviour. They employ techniques similar to those described in this paper in order to achieve this objective - for example, metanotation, concept maps, state transition graphs, Petri nets, and so on. Within my course, we also use the wiki phenomenon to study the nature of the dialogues involved in the computer-mediation of messages and ideas in terms of the semiotic principles that are involved. Of course, like concept mapping, wikis also provide us with a mechanism for studying people's mental models - which is an extremely important aspect of HCI.

Wikis in Project Management

According to Ebersbach, Glaser and Heigl (2006, p257), wikis can be used to good effect for managing projects. They can be used as the central medium with which to manage all phases of a project or they can be employed to assist in particular aspects of a project. It is this second possibility with which this vignette deals. In our recent research (Barker, 2007b) we have been using the *Blackboard* system as a tool to manage students' final year-practical projects. Its wiki facility (*Teams LX*) proved to be a valuable mechanism for providing a communal area within which project team members could describe their interests and expertise and also, share ideas and experiences relating to the different phases and aspects of the projects that they were working on. As is depicted schematically in Figure 5, students were thus able to form an online community of practice. Many students have reported how beneficial they found this wiki facility - both as a technical support tool and as a mechanism for increasing the social aspects of their studies.

Figure 5. Community of practice within a Blackboard wiki.

Evidence for the community of practice referred to above could be seen both in the comments that students made about each others' wiki pages and in the various electronic exchanges that took place between the students in the forums that ran alongside the wiki development.

CONCLUSION

Wikis provide a very interesting environment within which to create and share knowledge of many different kinds. Of course, they are also interesting artefacts in their own right. At present, there seems to be a proliferation of different systems - each with its own repertoire of functions/facilities and each having its own individual knowledge representation language. Obviously, in the interests of share-ability, some level of rationalisation needs to be introduced - that will facilitate the movement of electronic knowledge from one wiki to another in a transparent way. There are at least two mechanisms by which this could be achieved. One of these could be through the introduction of a universal

knowledge representation language (KRL) that all wikis could opt to adopt. Maybe, this could be based on a standard markup language like XML. Another possible mechanism that might be used to achieve portability (but which would not be as easy to implement) would be to create a series of automatic knowledge translators that would enable material embedded in one KRL to be effectively and efficiently mapped into an equivalent representation in a different KRL. Undoubtedly, as the future of wiki software unfolds, various solutions to the knowledge portability problem will emerge.

ACKNOWLEDGEMENTS

The author is indebted to a number of his colleagues who offered comments on and support for this work. These include: Dave Eagle, Chris Cooper, Steve Dunne, Kate Boardman and Bruce Ingraham. He also wishes to express his thanks to Tim Rice and Jon Dron for their valuable inputs. The author also acknowledges the Higher Education Funding Council for England for financial support through its National Teaching fellowship Scheme.

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