49. Harnessing Technology to Empower Mature Age Learners

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Abstract

The use of new online technologies and environments that combine innovation and a thorough understanding of educational theory to derive new models of learning are regarded as priority development areas in many countries including the European Union and Australia. In this paper we report on a project which is building 'Knowledge Spaces' using learning object technology to develop educationally sound online learning environments. Learning object technology promotes the use and re-use of educational content, and coupled with personalised environments and adaptive user interfaces, we are able to deliver relevant educational experiences to a diverse range of individual learners and communities of learners. We have developed a design evaluation model based on an extension of Reeve's pedagogical dimensions, and tailored it cater for the diverse and flexible needs of mature age learners. By understanding the learner preferences, and the needs and requirements of mature aged people, we argue it is possible to provide opportunities for learning using the online environment that will improve the quality, variety and relevance of learning. To assess the attainment of the educational objectives is normally a time consuming task, but in our technological environment we propose to match the learning modules with automatically generated test modules through the use of Automated Essay Grading technology, which grades unseen text essays and provides feedback in numeric and interactive visual form. The project outcomes will result in the application of new methodologies for the effective implementation of complex, intelligent learning environments with a view to constructing an online learning environment tailored to the specific needs of mature age learners.

An Online Research Forum for Prototyping a Mature Age Learning Environment

The need for mature age workers to remain productive in the workplace has emerged as a crucial issue for both government and education. The ageing population and an ongoing decline in population growth has led to a call to encourage the growing proportion of older people to not only continue working past the normal retirement age but to adapt to the recurrent demands made by employers for new and innovative vocational skills. This in turn places pressure on current government and education sectors to establish more effective and innovative strategies for addressing the skill and workforce requirements of employers. To date, little research has been conducted on the specific needs and preferences, or the development of effective teaching and learning models for mature age students and workers. Some information exists, however for the most part it has been derived from more generic research projects. Even more critical to furthering our understanding of their needs and preferences is the limited availability of information on the effectiveness of online teaching and learning strategies for mature age groups.

The use of the new online technologies and environments that combine innovation with a thorough understanding of educational theory to derive new models of learning are regarded by our research group as a priority development area. To this end, the Knowledge Technology Studio (KTS) has combined its expertise in building 'Knowledge Spaces' using learning object technology with Curtin's expertise in developing educationally sound online learning environments. The aim of this collaboration is to research and develop a teaching model tailored to the specific needs of mature age learners. By understanding their learning preferences, needs and requirements, we argue it may be possible to provide opportunities for learning using the online environment that will improve the quality, variety and relevance of learning for all involved. The project outcomes will result in the application of new methodologies for the effective implementation of complex, intelligent learning solutions with a view to constructing online learning environments that meet the needs of mature age people.

Addressing the Needs of Mature Age Learners

The speed of change in the socio-economic and education environments necessitates a continuous search for more effective and innovative strategies in addressing the general skill and workforce requirements of employers. In response to this need, KTS has collaborated with the Council for the Aging and National Seniors in Australia to provide a model for identifying the preferences, needs and requirements of mature age learners and to determine how large numbers could be provided greater access to a wide variety of skill development opportunities. Our research project will identify the needs of the mature age learner and investigate the advantages of applying learning object technology to facilitating those needs. By understanding the unique learning preferences, needs and requirements, and the factors that influence skills development, we envisage the provision of an online environment designed to deliver learning opportunities that will address the learning needs of mature age people.

Higher education institutions are continually investigating how to design pedagogically sound online learning environments while accommodating wide variations in students' learning needs. A major criticism of current learning management systems (LMS) is that they are not sensitive to individual learner preferences. In response to this limitation, a small group of online educational designers and researchers at Curtin have collaborated with KTS to examine the benefits of re-usable learning objects as an alternative technology.

A concise definition of a learning object has been difficult to determine as little consensus has been established amongst researchers that in turn, has led to interpretations that are based on the idiosyncratic prerequisites of the originating institution or individual. However, some agreement amongst researchers on what learning objects may or may not be has emerged over the past few years. For example, Wiley (2000, p. 4) defines learning objects as "elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science." Oliver (2001) describes learning objects as digital or non-digital entities which are used for educational or training purposes. In our schema, learning objects are viewed as re-usable teaching strategies or informational resources that can be presented in the online learning environment in a manner which supports the student's unique learning needs. Once created, all learning objects are stored in a content repository (CR) in digitised form, and managed by a content management system (CMS). When saved to a CR, learning objects can be quickly located and accessed, updated or modified without affecting the overall structure, or seamlessly combined with other objects to create a more comprehensive and effective learning process.

In the past, the development of re-usable learning objects was a response to a perception that there are economic benefits in designing learning objects that are reusable rather than repeatedly re-constructed (Barritt, Lewis, & Wieseler, 1999). Orrill (2000) points out that most discussions on learning objects has focused on technical design and as a result research conducted on how learning objects may support student learning has not been adequately addressed. Martinez (2001) for example, argues that the successful design of learning objects must involve: (a) accounting for the many factors impeding learning or facilitating learning; and (b) identifying and matching theories, conceptual frameworks, processes, relationships, methodologies, treatments, and environments to achieve successful learning for different types of learners. It is our view that incorporating these factors into object design is crucial to the development of educationally effective learning solutions. In essence, learning object technology has the potential to maximise the online learning experience and can be easily applied to the construction of solutions that adapt to individual needs and learning preferences. Therefore, the challenge for this project is to harness educational technology developments in order to deliver quality learning outcomes that are relevant to the needs of mature-age learners. Thus, we see our goal as methodology development, deployment and evaluation. The underlying technology has already been developed by KTS and thereby enables the project members to investigate and evaluate the use of learning object technology and the outcomes for learners relative to their individual and organisational goals.

Project Aims

The principle aims of the research project are to:

1. enhance the skill development opportunities for people aged 55 plus years old
2. develop procedures for the effective skills recognition and training needs analysis of mature age workers

3. understand the individual learning needs, design requirements and learning style preferences of the mature age student
4. identify the essential requirements for successful delivery of online solutions to mature age students, and
5. construct a prototype online learning environment, and evaluate it against the above four aims/criteria.
6. To ensure consistency and relevance to the needs of the mature age sector, it is considered necessary to draw upon the findings of the KTS 'Knowledge Spaces' project in relation to:

1. business demand – current and future demand for skills and how this applies to mature age students
2. employment preferences – how this will shape the needs and preferences for skills;
3. access to technology – direct and indirect access to online offerings and frequency of access
4. the relevance of the vocational education and training (VET) and higher education sectors to the provision of online offerings which are essentially designed for younger students
5. the ability of mature workers to function in an online mode, and
6. the knowledge and awareness of options available to mature age workers in terms of skills recognition, employment opportunities and (skills) competency acquisition.

An Online Research Forum for Prototyping a Mature Age Learning Environment

From the outset, the project members expressed a strong desire to establish broader channels for input since many viewpoints and emerging research issues are largely untested. In our view, what was lacking was a readily accessible, centralised forum for discussion, exploration, and development of new ideas gathered around the context of the available research documentation and the proposed research aims. As a result, the research project entered into a pre-research phase by constructing a web-based environment designed to encourage a coherent community of purpose which is focussed on the issues of developing a prototype model of an online learning environment for mature age people. The purpose of this 'early stage' research environment is to promote collaborative discussion, ongoing exploration, and the sharing of ideas and views as strategies and research objectives are formulated by the participating team members. A working model for the development of ideas is considered crucial to ensuring the initial phase of the research project will move forward in manner that is consistent with the original project aims.

The research project has now established the beginnings of a community of interest formed around a practitioner network that is focussed on the issues and needs of mature age learners. As various aspects are explored, resolved and discussed, practitioners will use this space as a knowledge incubator. A forum for pooling ideas and related thinking will further lead to a growing body of knowledge, ideas and discourse around identified topics that will inform current and future research, and ultimately, the prototype developments. New content will be added not just through the use of a central authoring facility but eventually by the wider community. To ensure a successful project outcome, all new content must relate to existing content either through a categorisation model or through association using meta-data or indexed content. Thus, all content is stored as learning objects. This requirement supports the need to incorporate a flexible, distributed authoring capability. The organic nature of how this collaborative working space is used will lead to the development of ideas that will improve through rigorous cycle of research, prototyping and systematic feedback from mature age people who will be introduced to the project as the research progresses. Once completed, the final version will evolve as an action research tool for all future inquiry and development.

The Theoretical Context

From the earliest days of computer-based instruction, the goal has been to create learning experiences that are: (a) *adaptive* to the individual; (b) *generative* rather than pre-composed; and (c) *scalable* to industrial production levels without proportional increases in cost (Gibbons, Nelson & Richards, 2000, p. 7). The key educational advantage of learning objects is that they can be applied in many different ways, even to varying contexts and for divergent audience needs. Instead of viewing the teaching process as a linear sequence with a defined beginning, middle and end, learning objects introduce the notion of clustered groups composed of independent, stand-alone segments of knowledge. While specific learning objects may be interrelated to form a conceptual group (or sub-group) they can also be linked to other learning contexts as discrete, independent entities. In practice, it is possible to combine or recombine learning objects in many different ways to form for example, a traditional topic, lesson or module. Alternatively, it is conceivable to nest a single object, or a group of objects formed around an abstract concept, theme, or issue to as many conceptual levels as required. Provision can also be made

for intelligent response procedures. For example, sub-groups of learning objects can be dynamically assembled to generate customised responses based on progress, areas of difficulty, student input, and the need for revision. There are a number of techniques that can be applied. For example: alert the student to the need for revision and present appropriate alternative materials; require the student to repeat a set learning sequence using material matched to a preferred learning style; and dynamically generate quizzes, assignments, or exercises that meet the student's immediate learning needs and assist to evaluate their comprehension levels.

Given the complexity and diversity of the issues outlined thus far, combined with the flexibility and potential benefits learning object technology affords, a meta-model of pedagogical design and evaluation is needed. For this reason, we have adopted Reeves' (1997) model of fourteen pedagogical dimensions that describe a range of design criteria for understanding, designing, and evaluating computer-mediated learning environments. In Reeves' original model a pedagogical dimension relates to a design aspect of multimedia or online teaching environment that directly affects learning. All dimensions comprise a range of pedagogical criteria against which comparative evaluations between one form of computer-based education can be made with another. Although the original number remains at fourteen, Reeves (1997, pp 3-15) has refined the dimensions to provide improved criteria for understanding, describing, and evaluating the design and implementation of electronic teaching environments. The dimensions of 'instructional sequencing' and 'structure' have been removed to be replaced by program flexibility (teacher proof/easily modifiable), and cultural flexibility (non-existent/integral). The dimension previously referred to as 'role of instructor' has also been modified to 'teacher role' (didactic/facilitative) to more accurately reflect the trend towards increased teacher involvement in online learning. However, in its original form Reeves' model did not provide for Gibbons' goals for computerised learning. Since learning objects permit a high level of flexibility and complexity for structuring resources (Bannan-Ritland, Dabbagh, & Murphy, 2001), Reeve's model has been extended to include the notion of multi-dimensional, multi-levelled continua of pedagogical design criteria wherein the potential to connect with other continua is without restriction. Thus, to ensure the full potential of learning object technology can be utilised without restriction, all continua described by the modified Reeve's model represent a non-linear, dynamic sequence of pedagogical design criteria. From a design perspective this means it is feasible to link any chosen position on a given continuum to any point on each of the remaining continua. In theory, there is no limit to the number of potential pedagogical permutations. A pedagogical model that affords this degree of flexibility is entirely consistent with the key attributes of learning object design outlined beforehand.

The additional continua that have been applied to Reeves' model relate specifically to the design of object-based learning environments. The additional continua provide for: technological complexity (simple/complex); navigational control (non-existent/teacher designed); learning object criteria (level of re-usability, granularity, contextualisation, adaptivity and scalability); level of specialisation (outcome as applied to required skills/knowledge levels); and responsibility for assessment (teacher/learner). The inclusion of these new continua extend Reeves' model of evaluative pedagogical comparison to incorporate a framework for developing advanced online educational learning environments. For each additional continuum, it is also intended to refine the respective theoretical and pedagogical underpinnings by taking into account three broad areas of educational design: (1) learner's needs (individual or group); (2) the teaching/learning process (the model of teaching and the theory of learning to be applied); and (3) the learning outcomes (as expected by the individual or required by the teacher). The final model is depicted in Figure 1.

Teacher Focussed		*Design Aspect*		*Learner Focussed*
Objectivist	←	**Epistemology**	→	Constructivism
Instructivist	←	**Pedagogical philosophy**	→	Constructivist
Behavioural	←	**Underlying psychology**	→	Cognitive
Sharply focussed	←	**Goal orientation**	→	Unfocussed
Abstract	←	**Experiential value**	→	Concrete
Didactic	←	**Teacher role**	→	Facilitative
Teacher-proof	←	**Program flexibility**	→	Easily Modifiable
Errorless Learning	←	**Value of errors**	→	Learning from
Experience Extrinsic	←	**Motivation**	→	Intrinsic
None / limited	←	**Accommodation of individual differences**	→	Multi-faceted
Non-existent	←	**Learner control**	→	Unrestricted
Mathemagenic	←	**User activity**	→	Generative
Unsupported	←	**Co-operative Learning**	→	Integral
None / limited	←	**Cultural Sensitivity**	→	Integral
Simple	←	**Technological complexity**	→	Complex
Fixed	←	**Navigational control**	→	Dynamic
Low	←	**Object re-usability**	→	High
Low	←	**Object granularity**	→	High
High	←	**Object contextualisation**	→	Low
Low	←	**Object adaptivity**	→	High
Low	←	**Object scalability**	→	High
Low	←	**Object skill/knowledge specialisation**	→	High
Teacher	←	**Responsibility for assessment**	→	Learner

Figure 1 - Reeve's (1997) model - adapted and extended (boxed, shaded)

Identifying a Framework for Learning Object Design

The greatest obstacle to the introduction of new technologies to the design of innovative educational solutions is that people tend to think about new technologies in old ways. What must be acknowledged is that online technologies now offer learning opportunities tailored to the needs and preferences of individual learners (Twigg, 2001). These needs and preferences might include adaptations to personal learning styles, choice of learning materials, customised study plans, continuous assessment, instantaneous feedback, and varying levels of teacher/student or student/student interaction. Whilst such applications are appealing, there are a number of influencing factors to take into account. For example, Artess (2003, pp. 6 - 7) has observed there is a tendency for teachers to represent the world to students in one or more of three distinct ways:

- enactive (knowledge from doing, participating);
- iconic (knowledge from seeing or imagining); and
- symbolic (knowledge from words or symbols).

The problem that arises is not all representations will appeal to all students. Students with sight problems may be less able to interpret the iconic, and students whose first language is not the norm might experience difficulty in learning symbolically. Additionally, students' choices in learning, for example preference of images over textual objects, or readiness to participate in group discussions while others may resist, points to an increasing need to provide for individual learning styles.

Until recently, the focus of research on learning styles has been directed toward the application to teaching and learning within 'traditional' classroom settings. With the advent of web-based delivery, our research has shifted to the application of learning styles and multiple intelligences theory to online design. As advances are made in applying learning object technology, the web offers an unparalleled opportunity for delivering personalised learning experiences (Martinez, 2001). For example, student activities could be electronically monitored as they engage in a learning activity. Their choice of responses, navigational preferences, and mouse movements can be analysed with the aim of generating a personal 'learning' profile. This profile may also comprise data related to the learner's credentials, learning habits, and grades (Jafari, 2002). Once established, the individual profile can be matched against pre-identified learning style criteria. By determining which learning style format best approximates the student's preferred learning approach, it is feasible to modify navigational procedures by dynamically adjusting linkage structures, and/or presenting alternative learning object content (thus generate multiple learning pathways). This 'intelligent' monitoring process also permits the dynamic modification of the type of to be displayed (and therefore the learning style format) by analysing the student's responses through regular comparison with the stored learning profile. Moreover, the monitoring process has the potential to yield

important information about individual differences in learning approaches and could provide valuable insights into how student learning in online settings may be improved.

To support and facilitate the preceding processes it is necessary to develop a core framework for the design and application of learning objects. The management system must also identify suitable learning objects that accommodate students' learning styles and in effect, generate pedagogically effective customised learning environments. In short, a CMS must adapt new or unfamiliar curriculum content to individual learning needs. Once established, this adaptive framework permits the exploration of additional 'intelligent' response procedures. Jafari (2002, pp 30 – 3) is a strong advocate for the use of "of intelligent agents that perform teaching and learning tasks on behalf of teachers and learners". A 'digital' tutor for example, may analyse learning profile data and intelligently determine a pedagogical strategy suited to the specific learning needs of individuals. KTS is currently researching and developing an intelligent delivery system that manages re-usable learning objects for application to various learning contexts. In response to Koper's (2001) call for a meta-model to describe complex relationships that make up a pedagogical design framework, our current research objectives are to:

- construct a theoretical design model for establishing complex pedagogical relationships among learning objects;
- define the structure for developing the content and behaviour of different types of learning objects; and
- evaluate the proposed design framework in terms of its relevance to learners' individual needs.

A Professional Community Evolution Model

One model that has been developed by KTS is the concept of community evolution that is used to explain how a community may become creative, innovative, community of learners. There are a number of parallel concepts in the field of community psychology, but examples of successful communities of interest are evolving online as well as on a geographical basis. Bringing together these ideas into a concept of an iterative model for community development provides some direction as to the type of online environments that will support this evolution. This model, combined with the lessons learned from other projects has also informed the value of this approach. Underpinning this evolutionary approach in online collaboration is the notion of distributed contribution, which means that the richer and more salient the contributions made by each member, the better and more informed the community debates and activities. Therefore, it is argued that the tools to support this approach must position the rich contributions at the outer edge, not in the centre of a given community activities to ensure all members are afforded an opportunity to contribute.

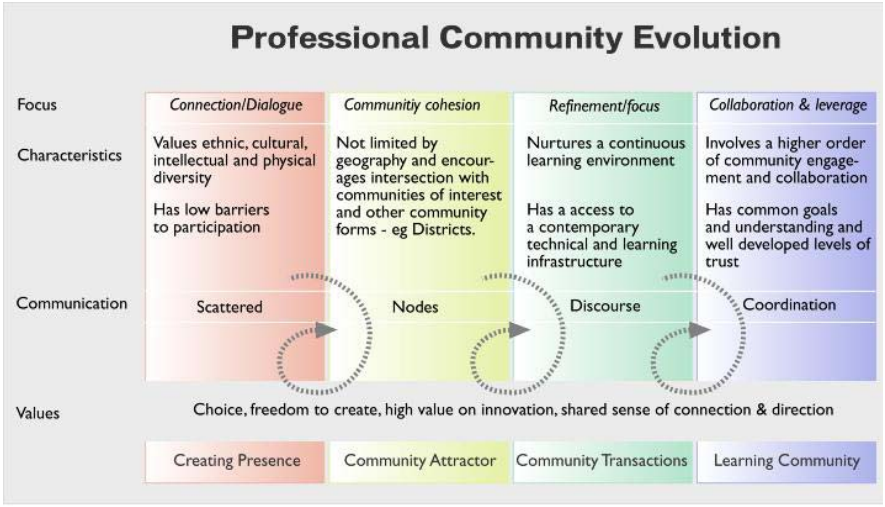

Figure 2 – Professional Community Evolution

The Dynamics of Distributed Contribution

There are two disparate models for an online environment that encourages community discourse and provides the means to add richer, relevant content to refine and illuminate issues. The first is a centrally seeded and managed discussion environment that directs and controls the group dynamics. This is appropriate in the case where policy is open for comment or when marginal discussion is required. The second, more appropriate to a learning and innovation environment, is where the contribution is spread throughout the community membership so that relevant issues may emerge from more concentrated discussions. This model is also more sustainable because any member can contribute to varying extents whenever the inspiration arises (coincidentally one of the strengths of WebLogs). Figures 3 and 4 illustrate the main differences between these models.

The necessary elements for a distributed contribution environment that uses a WebLog metaphor to create a dynamic sustainable community, must reflect these characteristics. This approach differs from that of a centrally managed environment and requires a shift in thinking in relation to the tools that support it. The modes of interaction with this environment will vary depending on role, topic and even the timing of a discussion. In this model, ownership and responsibility for the site is vested in the members themselves as opposed to the more common, centrally managed website design.

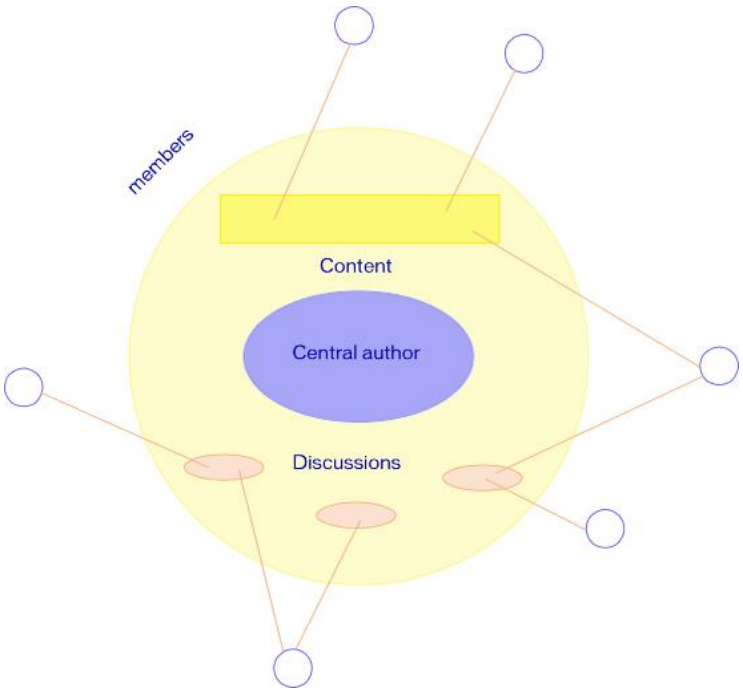

Figure 3 - Centralised Environment

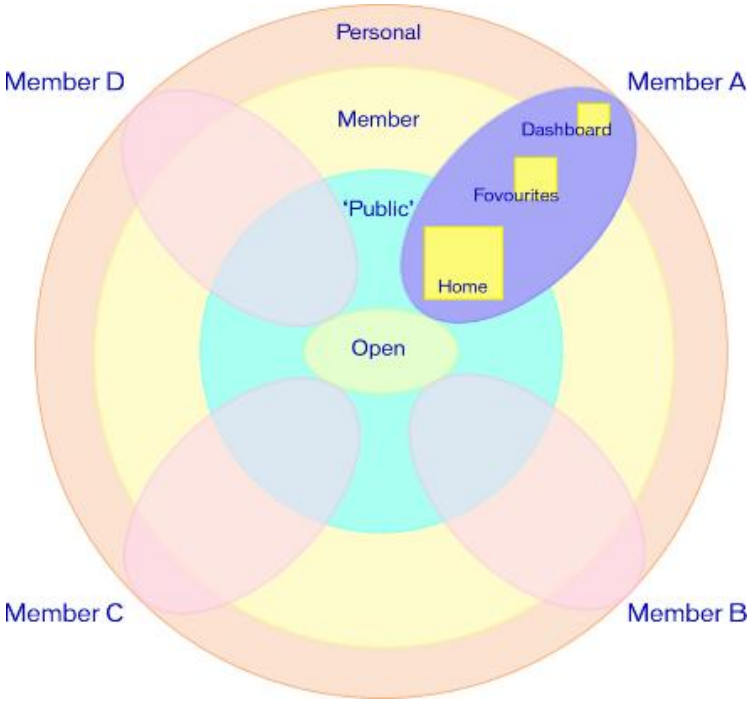

Figure 4 - Member-based Model

The member-centric design approach means that there are some tools that must be made available to all members while providing specialist tools to selected individuals. These tools should be modelled using familiar metaphors and hence be intuitive to use. In this instance, the 'folder' metaphor is used to organise content along with a drop-down menu of content types that allows access to relevant templates to display related content. A key feature of this design approach is the concept of individually configurable consoles for use by each member. The console is accessible from any part of the on-line research environment but each member can only access their personal allocated console space.

A differentiated authoring environment allows the tools that are made available to each member to be adjusted so that each member has access to the content types and authoring tools that best suit their needs. It can be daunting for some members to have access to too many tools and so a larger set of tools can be made available as members gain confidence in the environment. Information about recently uploaded content is also displayed in each member's console so that they can easily manage it as required. An example of a simple console is shown in Figure 5 . This particular example is tailored for an administrator who has access to a full range of tools.

Figure 5 - Simple Console Functionality

One of the key benefits of the member console model is the capacity for the community to begin the process of filtering relevant content that is of use to the community or a subset of that community. This is in effect a process of attenuation where the more relevant material is identified and shared quickly by members of similar interests. In this way, the members become a critical part of the process and therefore a mechanism to assist in this process was developed based on the familiar idea of favourites or bookmarks as used in a standard web browser. As a member finds content, WebLogs, files or even another member's home page, there is the capacity to add a link to their favourites folder that will then be displayed in the member's personal space. The favourites section of the member's space is accessible to others (and the 'public' if required). This allows not only the member to gain better use of the space but also provides a communal benefit in that as members may 'congregate' around issues of interest and debate or resolve issues by referring to each other's choices while filtering and focussing information to enable further debate. Each personal view of favourites now includes access to personal tools as shown below:

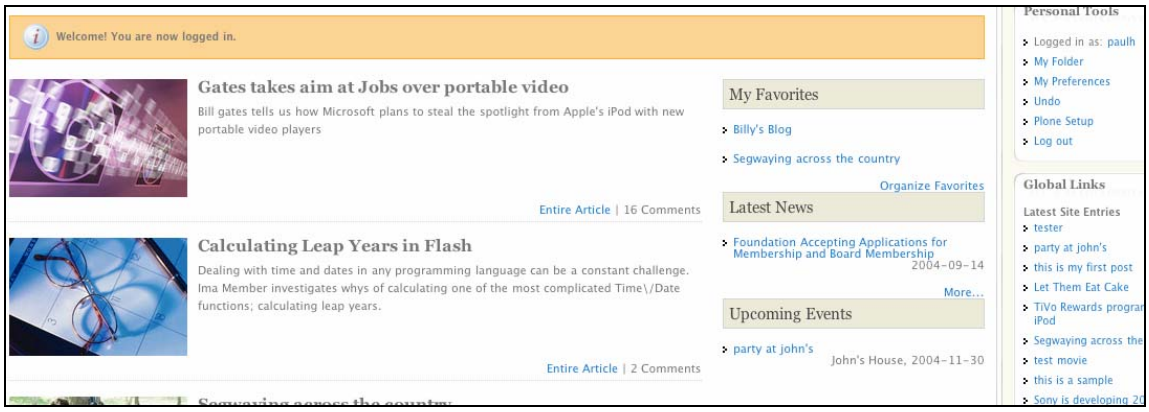

Figure 6 - access to Personal Tools

The idea of every member having a personal home page addresses the issue of the reluctance of some members to openly enter into discussions. This is an environment where they can share their thoughts by making choices about when and how to publish.
The member's page displays the member's photo, a brief biography, published articles, and statistics on their contributions. This view of each member is available to every other member and if they prefer, one member can add another member's home page to their favourites for quick reference. The choice of using an open discussion space is one that is naturally made by the community and is largely dictated by the community's interests.

Where to Next

We have created an online research forum to model a learning environment for mature age workers. Our purpose is to promote a community of interest and practitioner networks. Some possible outcomes are:

1. an educationally relevant methodology for designing and deploying learning objects consistent with Reeves' extended criteria (Figure 1);
2. a clear understanding of how learning object design will incorporate the identification and matching of proven educational theories which affect pedagogical design and learning outcomes for mature age learners;
3. a conceptual and practical framework to assist in the design, development and application of learning objects to online teaching practice (as applied to Reeves' pedagogical model);
4. a clear understanding of the processes, relationships, methodologies, treatments and environments that promote more successful learning for different types of mature age learners through the use of learning object technology in online teaching environments;
5. guidelines and procedures for the design and development of quality, educationally sound online learning materials and development tools matched to the learning needs of the mature age community;
6. (proven methodologies to partner investigators (KTS) for the ongoing development of their CMS and associated user interfaces;
7. two prototype online teaching modules as required by the partner investigator for delivery to a diverse range of mature age audiences with varying levels of complexity and expertise.

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