Technology succession and open source VLEs

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ABSTRACT
In this paper, the academic audience of Virtual Learning Environments (VLEs) is divided in to lead and conventional users. These users have different requirements, but as institutions move towards enterprise solutions for VLEs they are required to use the same systems. Currently commercial VLEs are the most heavily deployed in the education sector, despite some criticisms of the approach these systems foster. Using the analogy of plant succession, it is suggested that commercial VLEs have suitably altered the environment to the extent that open source VLEs can now be deployed. Such systems represent a compromise that can meet the needs of both sets of users. Some case studies that have recently adopted open source solutions are then provided to demonstrate this process.

Keywords
Virtual learning environments, e-learning, learning management systems, open source, technology adoption

1. INTRODUCTION
The seminal work in the adoption of technology is Rogers *Diffusion of Innovation* [11]. In it he describes the manner in which innovations have an S-shaped curve of adoption. The gradient of the curve can vary, depending on the innovation in question (the innovation needn't be technological, but the pattern and categories often apply to the uptake of a technology), and factors such as how much benefit, or commercial advantage it provides, the audience in which it is being adopted, the ease with which it can adopted, and so on. The key point is that there is usually a period where the innovation is used by a relatively small community, and then as it enters the steep part of the curve, uptake increases dramatically. This is also characterized as the 'tipping point', when an innovation gains a critical mass of users. There is also a flattening off of the curve, which suggests that beyond a certain point, a lot of time (and usually resource) is required to increase the number of users.

Similarly, Riggs and von Hippel [10] looked at innovations developed by users and those by manufacturers. They found that innovations by users generally enabled instruments to do new things, while those by manufacturers allowed users to do the same thing but more conveniently or reliably. These two groups again reflect the different demands of the revolutionaries and democrats. Von Hippel [7] goes on to differentiate between 'lead users' and more conventional users. Lead users are often ahead of market trends, and expect to gain relatively high benefits from a solution to the needs they have encountered there. They tend to modify products, and seek out products that can be modified. These modifications in turn benefit others, and the lead users in turn get the most benefit from any modifications.

Virtual Learning Environments (VLEs) may not be the most innovative educational technology to be found in use today, but they are one of the most pervasive, with 86% of respondents from UK HE institutions reporting the presence of a VLE in their institution [4]. This is perhaps why many researchers and educational technologists hold them in something resembling disdain. There are a number of charges often leveled at the more popular VLEs, and particularly commercial ones, which can be summarized as:

- They are content focused
- They have no strong pedagogy
- They are based around a teacher-classroom model
- They combine a number of average tools, but not the best ones
- They do not feature a particular tool
- They operate on a lowest common denominator approach
- They do not meet the needs of different subject areas
- It is difficult to exchange content between them, despite claims to interoperability

There is an element of truth in many of these claims, but the problems they represent are not as catastrophic to successful elearning as many of their proponents suggest.

There is something very familiar about this debate. If one substitutes the word 'Microsoft' for 'commercial VLEs' then many of the arguments sound similar to those leveled at a number of Microsoft products, principally the Windows operating system, but also tools such as Word, Excel and server technologies such as NT. The argument is actually about any large corporation with proprietary software, but it is best embodied in the debate around Microsoft, which acts as a proxy for all such companies. The similarity with the VLE market is strengthened when one considers that Microsoft have recently bought a large stake in the company providing the commercial VLE, Blackboard, and that in 2005 Blackboard acquired the other main VLE company, WebCT. This makes the scenario of a 'Microsoft' for educational software, ie a very powerful provider who has a near monopoly, all the more likely.

The products that serve the majority of any audience that reside in the middle part of the normal distribution curve (Von Hippel's conventional users) are almost, by definition, not the sort of tools that those who occupy the leading edge (the lead users) find interesting and suitable. The key accusation leveled against such products is their lack of flexibility. But flexibility often arises from a deep understanding of how such tools operate, and what they can be extended to do. This level of complexity is unsuitable for the conventional users. And such flexibility often leads to instability in the hands of the less knowledgeable.

2. CURRENT USE OF VLES

A 2004 survey conducted by the Organisation for Economic Cooperation and Development looked at e-learning in tertiary education in thirteen countries and a smaller survey by the Observatory of Borderless Higher Education reveal a good deal about the current situation regarding VLEs [9]. The survey showed that only 37% of respondents had a single institution wide VLE, while the remainder had a mixture of systems, often with one institutional and then a number local versions, although 90% expected to have an institution-wide system in next 5 years. Just over half of the institutions used a proprietary system, often with some open source systems in conjunction.

The move towards institution-wide systems means that increasingly the two audiences identified above, the lead users and conventional users, are forced to cohabit in the same virtual space. The question then is to what extent can a system be found that meets both of their needs?

The OECD survey seems to strengthen the position of commercial VLEs, but this may reflect the history of VLE uptake rather than its future direction. Three factors may see this position gradually undermined:

- Open standards – the development of open standards presents something of a dilemma for commercial VLEs. Customers expect the systems to comply with standards, and yet in doing so the commercial system begins to lose its unique selling point.
- Convergence of functionality – as system converge in terms of functionality, there is little to choose between commercial and open source options.
- Reliability of open source solutions – since 2004 a number of open source solutions have gained momentum to become serious rivals, most notably SAKAI and Moodle.

Perhaps of greater interest is what the survey reveals about the other systems that form part of the wider managed learning environment. Only 6.6% of respondents reported an institution-wide content management system (CMS) while 31% reported an institution wide portal, with a further 24% expecting to implement one within a year. Compare these figures with the almost total adoption of VLEs (only one respondent reported no VLE).

3. TECHNOLOGY SUCCESSION

What this demonstrates is that VLEs have achieved a level of uptake and penetration that has been rapid, but has not necessarily caused major disruptive changes. Most VLEs seek to match current practice, certainly much more closely than a CMS, which requires a number of contextual assumptions to be in place before it can be put to effective use:

1. Most content is available digitally – this is not too controversial, as all institutions have a good deal of information available digitally, but this is often administrative in nature and may not be the case for the majority of educational material. It may follow then that there is a requirement for all information to be produced in this way.
2. Content is in appropriately sized chunks – without absolutely requiring a learning object approach, for a CMS to be useful it needs to store chunks of learning content that can be aggregated together in different packages (usually courses). The granularity of the resources therefore needs to be suitably small to permit this, which has implications for how academics produce material.
3. Reuse of material is encouraged – while an CMS can be used to create content, and is particularly useful when doing so collaboratively, there is an assumption that the resources within an CMS will be reused in different contexts. If reuse is not part of the culture then the value to the institution of the CMS will be diminished.
4. E-learning plays a significant role in the overall educational strategy – a CMS is an expensive and sophisticated system, which requires a critical mass of resources for it to be worth the investment. This assumes that the CMS is used to support teaching, and is not an institutional CMS for storing and managing mainly internal, administrative documents.

From this perspective then we can ask to what extent can VLEs be seen as a Trojan horse for other e-learning applications and practices that begin to more seriously change the nature of higher education? Portals and CMSs are, arguably, more significant change factors (whether for good or ill), but the VLE can be seen as the *sine qua non* for the implementation of such systems.

There is an analogy with plant succession here. When there is a new environment, for example barren rock, a few pioneer species, such as lichens begin to grow. The acid from these decomposes some rock particles, and their own death creates a coarse soil. This is suitable for mosses, which require little soil, and in turn these decompose to enrich and deepen the soil, until it is suitable for some grasses to grow. The process ends with the establishment of a stable, climax community.

In e-learning terms, VLEs, and in particular commercial VLEs have acted as the pioneer species, moving in to the new environment and creating slight changes which make the habitat suitable for secondary colonizers. Commercial VLEs have done this *precisely* because they match the current model of practice, and match the standard purchasing and support model ie not in spite of the accusations leveled at them, which were set out above, but because of these.

However, in a succession model the role of colonizers is to adapt the environment for secondary colonizers. This is where current open source VLEs now come in to play, as well as closely integrated systems such as portals and eportfolios. The kind of environmental changes wrought by commercial VLEs include general acceptance of the e-learning approach, integration with administrative systems, staff development, recruitment of enthusiasts, changes in assessment practice, acknowledgement of tools already used by students, and so on.

Once secondary systems have been established, then the environment would be more receptive to systems that require more radical changes in practice, such as CMSs and Personalized Learning Environments (PLEs).

There seems to be a good case for the open source approach in the development of educational software. Firstly, there is a natural affinity between the open source and academic communities. The process of contributing code has been compared with that of academic review process. [1] suggest that "you give away your knowledge, not because you are altruistic, but because that is the way of career progression within the academic field. You give away knowledge and information in return for status and reputation. The acceptance of a gift by a community implies recognition of the status of the donor and the existence of certain reciprocal rights. Scientific contributions are gifts, as authors normally do not receive royalties or other payments for the publication of results in a journal…. The open source communities are driven by similar norms. You write a piece of software and provide it to the community. Your contribution is peer reviewed by the owners of a software development project and, if it is good enough, you get your credits in the open source gift economy. A good idea is usable in further research but also gives the owner credits." pg 318

Secondly, many open source contributors are employed in education and many projects start as educational projects, for example Moodle began life as part of founder's Martin Dougiamas' PhD. Thus it would make sense that in the area of VLEs, which are so central to the education process in the 21st Century, that a successful open source solution could be found. It has only been very recently though that open source VLEs have been able to compete with commercial ones in terms of usability and reliability.

With the development of more robust and user-friendly open source solutions, then it is possible that an open source VLE has moved some way towards becoming a mainstream technology and can thus satisfy the conventional users. At the same time, because they are open to development and modification, they still satisfy some of the requirements of the lead users. They thus represent a reasonable compromise between these two audiences, and in succession terms are ideally placed to take advantage of the colonizing work done by commercial VLEs.

4. SOME CASE STUDIES

4.1 The UK Open University

The UK Open University (UKOU) is a distance education university, and often operates with large student numbers, for instance there are around 300,000 registered users on its discussion systems and some courses have cohorts in excess of 10,000. As such, the requirements it has of educational technologies are not the same as though of more traditional, campus-based institutions. This has led to the UKOU developing a history of innovation and implementation of ICT in its teaching materials, but often this has occurred at the course, rather than institutional level. The UKOU thus faced the sort of tension detailed above, most academics had been accustomed to developing their own specific tools, and were acting in revolutionary mode, while as an institution the University recognized the need to make e-learning provision part of the mainstream and to offer a uniform quality of experience for students with regards to the technology they encountered on different courses.

In 2004 the UKOU launched a VLE project. It was in the unusual situation of having developed or bought in a number of tools and systems that commonly constitute a VLE, without having these integrated in to a recognizable VLE architecture. The tools it already possessed were:

- Discussion and conferencing - through OpenText's FirstClass system
- Authentication – handled through an LDAP compliant in-house system that allowed single sign on across all OU systems.
- Template driven content delivery – via and in-house system, Promises.
- Blogging – available on some courses through MovableType
- Audio conferencing – Lyceum, and in house product had been successfully deployed on a number of courses, particularly in languages (e.g. [6]).
- Assignment handling – a large scale system had been developed in-house to match the UKOU's award process.
- Assessment – a combination of QuestionMark Perception and an in-house product, Open Mark, were used, although there was no enterprise solution, and practice varied.

As well as identifying areas where the existing provision could be improved, for example compliance with IMS Content Packaging for content delivery, the systems audit revealed a number of gaps, for example in terms of student tracking. What was perhaps most lacking however was the conception of these components as parts of a larger system.

After an extensive review and consultation process it was concluded that a service oriented architecture (SOA) approach that integrated existing applications and the development (or procurement) of tools to fill existing gaps represented the best option.

However, while SOAs have gained a good deal of attention, there are relatively few examples in operation. One is the Tasmanian LeAP project [8] which uses a service oriented approach to create a flexible VLE. Perhaps the best known of such approaches is the SAKAI initiative (http://www.sakaiproject.org), which aims to deliver the following components as open source.

So, while a SOA represented a good architectural vision and was a worthy goal, there were also more pragmatic needs regarding the timely roll-out of the VLE and also the need to provide clarity to a number of related projects which would be interfacing with the VLE. For example, an eportfolio review was under way and this needed cognizance of the implementation of any VLE and detailed technical integration methodology.

A further review concluded that the adoption of the open source VLE Moodle represented a practical middle-ground between a fully developed SOA approach, and a proprietary VLE. The advantage of the Moodle option were as follows:

- Its existing tool provision allowed the UKOU to shortcut the development of some tools
- The system could be integrated with existing systems
- Access to the source code meant the system could be adapted to our specific needs and to our development plan, rather than waiting for releases.
- It mapped on to the UKOU's strategic directives, particularly that of being a leader in modern pedagogy and technology
- The UKOU could contribute to and benefit from an existing Moodle community.

It is estimated that the adoption of Moodle will reduce the implementation time of a service oriented VLE by 25% in the UKOU. Currently Moodle has been integrated with the existing authentication system, assignment handling and FirstClass. The existing assessment tools within Moodle will be utilized, although in some instances integration with OpenMark will also be deployed. The content delivery, management and navigation functions of Moodle will be adopted wholesale, although with customization to a UKOU look and feel.

4.2 State University of New York

The State University of New York (SUNY) has 64 campuses distributed over New York state. It also offer an extensive online programme through SUNY Learning Network, which has over 100,000 students, 3,000 staff and 40 of the campuses participate. Any VLE system therefore needs to support purely online, blended and campus based education, over a widely distributed system.

In 2005 they embarked on an extensive review programme to find the solution for their next generation VLE (having used the IBM Lotus Notes/ Domino system for a number of years). Their approach comprised four main stages [12]:

1. Assessments and Assumptions – this established the foundational data that would be required of any VLE technology candidates. These reviews included technical and IT environment assessments, assumptions on requirements, and assertions for long-term trends in VLE development. The conclusions from this process were that the current system could no longer meet their needs and that a portal was "the best technology foundation for a modern LMS."
2. Analysis of Task Force Recommendations - a Task Force made recommendations for a single VLE system across all campuses for teaching, learning, and research. The recommendations of that task force were then analyzed in order to form the necessary criteria for evaluating candidates for a new VLE solution. Five key evaluation criteria were the produced for use in the next stage:
    a. Strong support for integration of new teaching and learning tools via open standards.
    b. Student-centric rather than course-centric application design.
    c. Support for the IMS Learning Design Specification.
    d. Native interoperability with SUNY's portal environment.
    e. Strong integration capabilities with campus IT systems
3. Evaluation of Potential Solutions - using both the assessment studies and the analysis of the Task Force recommendations, potential solutions were evaluated. Once a strong solution had been identified, the team prepared an overview as well as a snapshot of a functional specification for production of that solution. The products they evaluated were Blackboard, WebCT, ANGEL, Academus, Moodle, Sakai, dotLRN, as well as the combinations of Sakai + Moodle + uPortal, Sakai + Academus + uPortal and Sakai + LAMS + uPortal. Their final recommendation was for a component approach, which combined uPortal, LAMS and a range of other open source tools, which they believe "Provides a much richer feature set than any currently available single-platform LMS."
4. Implementation Strategy - an implementation strategy for the proposed LMS solution was formulated. This is based around an 'agile' development plan with regular updates and some outsourcing of development.

The SUNY solution is summarized as "a component strategy, as no single-platform LMS solution exists today to meet our needs. This powerful component strategy would integrate several carefully chosen Open Source projects, each with strong technical compatibility, resulting in a whole far greater than the

sum of its parts." This is unusual in a number of respects. Firstly, it places the portal at the centre of the system, rather than a VLE. Secondly, their process places a strong emphasis on the Learning Design specification, with it being one of the five key criteria that was used to determine the final system. This leads us on to the next noteworthy point about the SUNY solution, namely the selection of LAMS as their main VLE tool. While LAMS has gained a lot of attention and been successfully deployed in local contexts, it is rarely employed as the central system. The SUNY implementation will be an interesting test of how well LAMS manages this promotion to centre stage. The last point of note from the SUNY study is the conclusion of a component strategy, as with the UKOU a service oriented architecture was recognised as the optimal solution in terms of pedagogic requirements and flexibility, but existing open source solutions provided a convenient means to achieve this in a short timescale.

4.3 New Zealand Open Source VLE

Moodle was selected by The New Zealand Open Source VLE project to form the basis of their collaborative development. The project is a coalition of twenty tertiary education establishments in New Zealand who have committed themselves to using and developing an open source VLE. This is driven by a desire to share the costs of e-learning development. This made an open source option the most logical choice, so it was not a choice between open source and proprietary but rather a choice between open source alternatives.

Their objectives of the project are [13]:

- Significantly reduce the total cost of ownership at a system wide-level
- Select and contribute to open source communities
- Encourage collaboration and user networks
- Reduce to barriers to entry: technology, support & professional development
- Accommodate flexible pedagogical approaches
- Support localisation - including Maori and Pacific Island languages
- Advocate for interoperability
- Catalyst for innovation

They evaluated three open source options in detail: Moodle, ATutor and Ilias. They used two frameworks for their evaluation: Chickering and Ehrmann's [5] seven principles of pedagogy and technology selection and Britain and Liber's [2] Framework for the pedagogical evaluation of eLearning environments.

They chose Moodle in 2004 because they felt that it offered:

- An open and active community with a critical mass of developers.
- A modular system architecture
- Relatively easy integration with other systems
- A course / student focus rather than tool-centric
- Adaptability

Using Moodle as the basis, each of the participating institutions creates a distinctive and localized version. The second stage of the project is focusing on the development of additional tools such as a personalized portal, personal development planning (PDP) tools, e-portfolio, simulations and instructor support tools.

5. DISCUSSION

As e-learning moves from a peripheral to mainstream activity (e.g. [3]) Higher Education institutions in particular face a difficult dilemma. They need to move to the provision of standard, robust e-learning technologies that are operated institution-wide so that support can be centralized, teaching quality can be audited, staff development programmes can be conducted, resources can be allocated, and so forth. This consolidation of e-learning services however can lead to the alienation of those academics who have developed specific applications and who have very specific demands regarding educational technology. There are two main audiences for the VLE within an institution, the lead users and the conventional users. The requirements of the two audiences are very different, yet they are required to both operate within the constraints of the institutional VLE.

For the conventional users a commercial VLE has thus far been the preferred option as it provides a robust solution, with appropriate support and training material. Such systems have been designed specifically around meeting the needs of such users and although they may be limited in some respects, they provide the main functions within an easy to use framework.

For the lead users, a solution based around a more service oriented architecture is likely to be appealing. This is both technically more interesting and also more flexible so they can develop a best of breed approach, integrating their particular tools as required.

The experience of the case studies suggests that an open source VLE option, represents a compromise between these two options, that can potentially satisfy the needs of both audiences. The system is sufficiently robust, and there is a sufficiently large user community for it not to be viewed as a research tool. It is however also flexible, and adaptable to the needs of any particular institution, so those with specific technical requirements can use the VLE as the 'backbone' of a service oriented solution. Due to much of the work done during the implementation of commercial VLEs, they have ironically, altered the environment suitably so that open source VLEs are now a viable enterprise solution.

It should be recognised though that an open architecture, open source VLE represents only one half of the interoperability equation. The other half relates to content, and being able to populate such environments with a range of content that suits the needs of different learners. In this respect there are a number of important developments. The first is the development of open standards relating to content, such as metadata for describing content, and content packaging for exchanging structured resources. The second important development in this area is that of open educational resources. This work was initiated by MIT's

Open CourseWare project, which aims to make all MIT teaching materials freely available. Many other universities have followed suit, including some in Japan, China and Latin America. The open educational resource movement also builds on the work of learning object repositories, such as MERLOT. This work is potentially significant for open VLEs because it helps to blur boundaries between institutions and aids the personalization process by creating a much wider range of resources to draw upon.

Although the concept of reusing material, particularly in the form of learning objects, has been around for a few years now, such reuse has not been apparent in most institutions. However, as the move towards open VLEs becomes more evident, so the notion of reuse becomes more prevalent. The initial work on reuse and standardization focused on content, for example metadata and content packaging were amongst the first specifications to be produced, while software interoperability is relatively recent, for example with the development of SAKAI and the IMS Tools Interoperability Profile. It may be that tool interoperability is in fact a bigger driver for reuse than content, and reuse of content will follow once open learning systems have been established, because following the concept of technology succession, such systems change the environment in which they operate, in this case making reuse a more acceptable concept.

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