

# Deploying Mission Critical Learning Management System Using Open Source Software

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# Deploying Mission Critical Learning Management System Using Open Source Software

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## ABSTRACT

As more institutions of higher education confront budget cuts and financial crisis, open source Learning Management Systems become increasingly attractive, providing cost effective and efficient alternatives to commercial Learning Management Systems. This interpretive case study investigates the implementation and adoption of an open source based LMS at an university located in California. The research not only examines technical aspects associated with the adoption decision, including motivation, performance, and total cost of ownership, but also explores how IT staff and administrators react to the implemented LMS.

## Keywords

Open Source Adoption, Learning Management System, Total Cost of Ownership.

## INTRODUCTION

As more institutions of higher education confront budget cuts and financial crisis, open source Learning Management Systems (such as Moodle and Sakai) become increasingly attractive, providing cost effective and efficient alternatives to commercial Learning Management Systems (such as Blackboard). Since open source software typically licenses its users to access, modify and distribute its computer program source code for free (opensource.org), those institutions that adopt open source solutions are able to deploy campus wide LMS without paying a software license fee, which may constitute significant expenses in the case of commercial LMS adoption (Angelo, 2002). In addition, the free source code access also allows developers the flexibility to modify the software and customize the learning environment to better serve the education needs of students and faculty within a specific institution (Coppola and Neelley, 2004; Courant and Griffiths, 2006; van Rooij, 2007).

However, while the open source software license is free, the total cost of ownership associated with deploying and supporting a campus-wide, mission critical LMS is not. This interpretive case study investigates the implementation and adoption of an OSS based Learning Management System at an university located in California. The research not only examines technical aspects associated with the adoption decision, including motivation, performance, and total cost of ownership, but also explores how faculty and students react to the implemented OSS LMS. The policy implications from the study will also be discussed to highlight the steps that university administration may take in order to facilitate such adoption.

## THEORETICAL FRAMEWORK

According to Orlikowski and Gash (1994), The “technological frame” refers to “subset of members’ organizational frames that concerns the assumptions, expectations and knowledge they use to understand technology in organizations.” It is argued that technological frame is a powerful concept because people’s assumptions, expectations, and knowledge about “the purpose, context, importance and role of technology” will have lasting impact on how those technologies are designed and used. In addition, since even a single technological artifact may be interpreted differently by different social groups within an organization, most likely, different technological “group” frames may be constructed across different social groups. On the one hand, multiple technological frames reach *congruence* when they are aligned or agreed upon with each other on key aspects of the technology; on the other hand, incongruent technological frames are suggested to contribute to difficulties and conflicts surrounding technology adoption and use.

In this campus wide OSS LMS adoption, we intend to examine technological frames of two key groups within the university - the developers and administrators. Next, we will briefly review what have been discussed in the literature that is relevant to these technological frames.

The technological frame of OSS administrators and developers greatly concerns the open source nature of the LMS itself, and the benefits and costs associated with its adoption. Although the majority of the research conducted on open source software so far has focused on the phenomenon of software *development*, attention has been drawn increasingly to OSS *implementation and adoption*. The following benefits and barriers of implementing OSS in public sector organizations have been identified in various literatures (Coppola and Neelley, 2004; Fitzgerald and Kenny, 2003; van Rooij, 2007, 2009; Waring and Maddocks, 2005):

	OSS Adoption
Benefits	<ul style="list-style-type: none"> <li>• Low licensing cost</li> <li>• Open standard and interoperability, avoid vendor “lock-in”</li> <li>• Freedom to modify the code</li> <li>• Greater choice and control for end-users</li> <li>• Innovation</li> </ul>
Barriers	<ul style="list-style-type: none"> <li>• Lack of documentation and support service from the OSS provider</li> <li>• Technical skills required to implement, customize, and maintain the software</li> <li>• Steep learning curve and end user training and support</li> </ul>

Under the pressure of steep cuts in higher education funding and price hike due to commercial vendor mergers and acquisitions, more and more higher education institutions are looking into OSS as a cheaper alternative to commercial LMS solutions (von Rooij, 2009). However, as noted by Waring and Maddocks, the long term trend of outsourcing has caused de-skilling of the IT workforce in the public sector; in other words, acquiring the technical skills needed for OSS implementation could be costly. Indeed, Moore (2002) cautions that managing open source courseware and knowledge development can be almost as labor-intensive and expensive as buying a proprietary product and adjusting it to fit a particular institutional culture. Alterman (2004) suggests that only the top-tier institutions who is rich in IT support, namely, the doctoral and research Carnegie 200, can afford bearing the cost associated with OSS implementation.

This research study investigates the implementation of an open source learning management system at an urban university located in California. The original research included analysis on how two different groups, including the IT staff, and administrators in the university, made sense of the new technology and how they react to it. Before presenting and discussing the findings, we first describe the research site and methods used.

## RESEARCH SITE AND METHOD

The study was conducted within one of the universities in California □ AAU (a pseudonym), who adopted an Open Source Learning Management System (OSLMS) after its contract with a proprietary commercial LMS (PCLMS) expired in 2007. The research employed a longitudinal qualitative case study approach to collect and analyze the data, including participant-observation, in-depth interviews with faculty, administrators and staff. Fifteen in-depth interviews were conducted with faculty and technical staff between 2008 and 2012. All interviews are subsequently transcribed and analyzed using qualitative data analysis software ATLAS.ti.

## RESEARCH FINDINGS

### From PCLMS to OSLMS – Decision to Switch

In winter 2002, AAU upgraded their PCLMS to a newer version. As one of the earliest adopters of the new version, the university experienced significant problems during the upgrade process. Serving as the PCLMS support unit within AAU, the Teaching Excellent Unit (TEU) witnessed those issues first-hand. According to one of the TEU staff (an OSS champion):

*“We ended up having blackouts, we had a 13 hour outage during finals week where their salesperson was here running scantrons with the large class instructors. So a lot of concern because it was all semester long we had, it[PCLMS] would just turn off and be out for a couple of hours...”*

Besides service outages, one of the fundamental concerns is that PCLMS is not responding to the growing needs of large size classes, which become important as AAU faces deeper and deeper budget cuts from the California government:

*“Part of the problem was we might have been used the tool in ways that they were not prepared for. For instance, we had a class that went over 1000 students. And they had only 999 for that field as the highest you can go. So PCLMS forced us to break a class into two sections because they couldn’t handle it...we found that they were not on our time line. When we said we have this problem, they said, we will fix it in six months. When we release that new version. But we need that answer now. Our faculty is having problems [in the classroom].”*

In December 2002, about 50 faculty members participated in the focus group studies conducted by TEU, and they agreed that LMS alternatives other than PCLMS should be investigated. TEU subsequently evaluated six open source and six commercial LMS products. After extensive usability test and pilot study, which lasted over seven semesters and involved over 400 instructors, the OSLMS solution clearly wins out as the better alternative. In Fall 2006, a comprehensive report was submitted to the provost, recommending adoption of the OSLMS. In June 2007, AAU officially switched their LMS from PCLMS to OSLMS, the TEU is responsible for building and maintaining a customized version of OSLMS – which is known as eLMS on AAU campus, and a new director was hired to manage the unit.

One hard lesson that TEU had learned from the PCLMS upgrade episode, was that flexibility and the ability to customize is very important because LMS is mission critical to AAU, the whole campus relies on it, therefore they would like to have more control of the system, which proprietary solutions would not be able to provide. On the other hand, as AAU increasingly faced deep budget cut, contract renewal with PCLMS would be too costly. By adopting OSLMS, AAU could save substantial license fees. Therefore the decision was also driven by the need to reduce IT cost, especially from the university administrative point of view.

### **Early Days of eLMS Implementation**

As an Open Source Learning Management System, OSLMS is primarily developed on top of the LAMP stack, its underlying platform technology - Linux, Apache, MySQL, and PHP - is also OSS based. In order to customize and maintain OSLMS on campus to support the teaching and learning activities of the faculty and students, TEU needed not only hardware resources but also technical skills to manage the LAMP stack, especially PHP programming and MySQL database administration. To fulfill the needs, TEU created some entry level positions, but most of the new hires were formal student assistants who did not have extensive industry experience in managing large scale online systems.

The early days of eLMS implementation proves to be very challenging for TEU. After terminating PCLMS usage, many AAU faculty switched to eLMS for their teaching needs, and eLMS quickly became one of the largest OSLMS installation in North America. As the student base grew, performance and scalability issues emerged and noticeable system slowdowns are frequently experienced by its users. It was commented:

*“We have some major slow time, where people would login and it would take a minute for the page to load, or people will take a quiz or click a button, it would not immediately go through to the server. We found that there are a number of issues that cause this, part of it was some of the ways that people were using the tool, part of it was how it was configured, part of it was our hardware”*

Some large online courses in particular are causing scalability issues by introducing pedagogy that would require students to access the same content at the same time. It is explained:

*“but when you have 1,500 students in one class, with the same deadline of midnight on Wednesday, and they are all taking a quiz, we would see 16,000 quiz attempts in a 12 hours period, nobody else in the whole [OSLMS] community has seen this.”*

Besides scalability issues, upgrade related stability issues also haunted TEU in the early days of eLMS implementation. Following the open source tradition of release early and release often, new versions of the OSLMS are released on monthly basis. At the beginning, TEU followed the OSLMS release cycle closely, upgrading to newer version of The OSLMS frequently. Due to lack of Quality Assurance testing procedures, TEU encountered frequent system crashes during the upgrade. The decision to upgrade to the OSLMS version x.y is particular controversial, one developer explained:

*“The tipping point I think was version x.y... We had a vote and I didn't vote for upgrading. I said that, based on the manpower that we have and the resources, we can't*

*test this out thoroughly. But the [manager] really wanted to upgrade to x.y, and it was just a nightmare...the automated process would not complete, we were manually downloading the files for each course, manually takes a x.x (an earlier version) courses and make it become x.y compatible and uploaded into x.y and restore it."*

### **Stabilize the eLMS**

Joining TEU after the eLMS decision was made, the newly hired director was initially not prepared for managing open source software. It is explained:

*"So I didn't have anything to do with that decision. I was pretty surprised and a bit frightened at the fact that not enough was really on paper in terms of, there wasn't a project plan that I'm used to seeing, there wasn't a scope of the project...because I came from a really structured project environment for a proprietary software, if we had all these project plans in place around that, what is this leap of faith into this open source technology without this documentation?"*

In 2008, two faculty experts on OSS were hired as consultants to help TEU implement methodologies to better manage eLMS. One of the first things they implemented is to develop a policy on how and when to do upgrades:

*"First of all there were no procedures in place to define what should be the process of maintaining and upgrading these systems. Because everybody said, well, this is open source and when an open-source bug is fixed we implement it and we keep going. But you have to follow the natural timeline for your business processes, which in this case is the academic process. The academic process has a beginning of the academic year and an ending of the academic year. So every academic year we would do a major change. Minor changes like bug fixes we would allow if it's something critical, but we wouldn't go from an OSLMS, let's say, version x.xx to x.yy or something. Only on an annual basis, where there would be major changes."*

Secondly, the faculty consultants recognized the importance of Quality Assurance testing, and implemented the testing procedures to ensure the stability of the system.

*"They had no testing, but for ongoing work you have to decide when you are going to implement changes, test them and then put them into production. So you have to distinguish between development, testing and production. So our second task was to instill a process for upgrades and testing and we hired student assistants to write test case scenarios."*

Under the suggestion of the faculty consultants, TEU also employed virtualization technology to backup the system more intelligently.

*"So what we would do is to create a virtual system which consisted of the Linux operating system, that was the platform, Apache, PHP and MySQL of a particular version, married to a particular OSLMS version with its content database and that would be a virtual system. And we would create a new virtual system for every new semester."*

According to one of the faculty consultant, virtualization becomes the key to stabilize the eLMS.

*"You've got to remember, we've got Linux upgrades, we've got Apache upgrades, PHP upgrade, and on top of that you've got the MySQL. So all four components plus OSLMS are changing. It's a lot of different pieces that have to be synchronized. So unless you create this kind of environment with virtualization, you are dead. You can never keep up because every time you make a change you have to start testing all over again. Once the concept of virtual machine is accepted, then it becomes a much more stable environment and also a scalable environment."*

In addition to make technology changes, the faculty consultants also helped to educate the TEU members on how to assess the level of maturity of open source products so that they can make better decisions on OSLMS version control.

*"I think the maturity stuff went well. They understood the reasoning behind assessing the maturity of a product, because it's not just that you have an upgrade so you should go up*

*to the next level. You look at the stability of the software, you look at the technical support, documentation and all those things. And so that was helpful and we sort of did that for a couple of versions.”*

In order to keep the faculty and students more involved in the process, an eLMS User Council was also formed. The council consists of faculty, students, administrators as well as TEU representatives. It played important role in defining eLMS related policies and procedures, including an 18-month backup policy and a service level agreement. On the technology side, TEU not only acquired MySQL commercial license to access support from MySQL professionals, but also sent staff members to MySQL conferences to get trained on the specifics of this database technology. In addition, TEU expanded its organizational structure by merging with another technology group on campus. After these initiatives have been implemented, TEU gradually developed expertise in managing a large OSLMS installation, eLMS performance was significantly improved and stabilized.

### **Contribution, Collaboration, and Leadership**

As the eLMS got stabilized, TEU was recognized as a leader in OSLMS implementation and support, making important contributions to OSLMS community, California education system and beyond.

#### *TEU and OSLMS Community*

While the OSLMS has been widely adopted across various educational institutions, it is different from a typical open source software project where significant overlap exists between developers of the software and users of the software. One developer explained:

*“The (OSLMS) community basically doesn't have a really solid team for professional testing. The core team members, it's a very interesting mix of younger developers who always want to just try to implement new features but they don't care about whether those new features might be pedagogically sound or stable. They just know that they did something cool. So they just want to roll out a new feature without thinking about usability, without thinking about scalability or how easy it can be maintained. So I can see that there is a gap in terms of what the developer wants to do, and then the voice from the teacher. Also, it is very different from Linux kernel, that kind of open source project. Where most of the developers really know the code and also they are the users of the code. The OSLMS community is different in the way that most of the users might be teachers and students and they might not know all the technical details.*

Due to the gap between developers and users, the features that OSLMS team develops sometimes are influenced by the interests of some small number of community members who have more resources to spare.

*“Because of the nature of the software, the direction it's heading might not be always aligned with the majority of the higher education Institutions. It could be skewed by minorities - Because the OSLMS core team is actually acting in some ways like a mercenary. So whoever will be paying the OSLMS core team a lot of money and say, hey, you do this, they would just do it. And after they do it, most likely the newly written code will be added into the core code and got released despite that it might not be really helpful for most of the universities.”*

However, since TEU never had enough resources, especially skilled PHP developers, TEU really need to rely on OSLMS community to improve the software itself. According to one of the TEU developers, making contributions in community forum is a very effective way to get noticed and to establish reputation within the community.

*“The way that I have kind of established my own voice is to volunteer a lot in the community. Either help out with testing or with documentation or with reports and things like that. Actually, if you go into the documentation system, there are a lot of articles that were written by me about scalability, about some of the system monitoring tools that you can use. And people, especially the OSLMS core team, they will recognize you with your name. And then they will pay more attention to you.”*

Besides engaging OSLMS community through forums, TEU also made various contributions in different areas, one of them is to maintain OSLMS modules at the development level. One of the OSS champion in the team explains:

*“We have taken ownership of certain modules or blocks as they are called. So now we maintain the [a module name] for the whole community. So when an upgrade happens, we test it to make sure it works with the upgrade and make any changes necessary and then release it back to the community.”*

Secondly, TEU tries to influence OSLMS core team on developing more stable software:

*“Because of our size, some of the things that we’ve been experiencing that other campuses have not, we’ve been in communication with the core team a lot trying to tell them, hey, here are some issues with scalability that, when [an university] gets big, when [another university] gets big, they are going to face these things too so it’s to your advantage to kind of learn from us and make the fixes. If you help us out you’re actually going to help out a lot of people who are make decisions about moving to an open-source tool.”*

Third, TEU also engages in the OSLMS community by actively participating in and hosting OSLMS conferences:

*“They already recognized us as a national leader. They’ve had me be the keynote speaker last year. We co-organized the conference this year. And then people call me from around the country to ask questions. And some from Canada. I’ve had one from Israel. Santa Barbara. All over the place. People want to know about OSLMS...In 2008 OSLMS conference, the core team actually came to our campus to visit every one of us, and that’s because they recognized us.”*

The developer comments on why it is important to build a close personal relationship with OSLMS core teams:

*“I recognized that we will never have enough resources to handle this kind of open-source project. And we really need to tap into the community, especially the core. Because most of the code was written by them so if we have good relationships with them, they probably will listen to us more instead of just going with whoever paid them and implement those. And I think that strategy was good because for a while I think OSLMS was really paying attention to QA and now they even embedded QA into their whole development process. That is a very important contribution, simply because we are very close to the OSLMS core team and we gave them a lot of feedback.”*

### *TEU and Regional Campuses*

Beside establishing reputation within OSLMS community, the success of eLMS implementation also help TEU establish leadership within the California education system. The OSS champion regularly provides advices to other campuses regarding OSLMS implementation.

*“When I consult with different campuses, I give them two strategies for finding answers: I tell them, for questions that are not emergencies use the OSLMS discussion forums. You’ll get an answer within three to five days. But if you need an answer today, find a small group of campuses that are either a little bit ahead of you or at the same place and get their phone numbers. So I said, I can be one of those phone numbers.”*

TEU also developed online OSLMS documentation that can be shared among sister campuses and community colleges. According to the TEU OSS champion:

*“We have the how-to documents for people, both faculty and students, to learn how to use eLMS. And because of this consortium with other OSLMS campuses, we modified this tool to allow multiple campuses to use the same information. We worked with some community colleges, and they decided to move to OSLMS. So we gave them all of our training materials and our OSLMS course for instructors which has lots of pedagogical information and technical how-tos. So they took that and said, thank you thank you., And then a month later they said we made podcasts from all of your documents would you like those?”*

As TEU build expertise in managing OSLMS installations, it is possible for them to potentially generate revenue by supporting other campuses who are interested in adopting OSLMS:

*“We could be hired by other campuses with zero programmers to make a widget. We can do that if we want. We can also, if we build up a strong help desk, we can provide help desk for a campus that has no help desk. Those are the types of things where you can start looking at, well if we invest in staff, and we find that we are getting past the break even point, then how can we bring money in to support, through development or even through consulting. We can start charging for me to go to campuses or something.”*

#### TEU and AAU

After AAU switched from PCLMS to OSLMS, it has been widely adopted by faculty, staff and students on campus. It is commented:

*“Because OSLMS is a little bit easier to use according to the faculty and students, we have been able to encourage many more faculty to move beyond just storing their documents for students to download. Now they are engaging students in different types of activities like discussion forums or self-assessment quizzes or chats or wikis...We have over 250 organizations and committees using eLMS for non-coursework. We have HR who wants to use it for all their training sessions. I’m trying to push the defensive driver training because I don’t want to go to that room for three hours, I want to just go through the quiz.”*

Most importantly, AAU is able to achieve the economy of scale by reusing the skillset they invested in OSLMS to integrate with other tools to better serve faculty and students. For example, TEU is able to develop and support other tools, including a content archive tool, a lecture capture tool, and online syllabus tools etc. It is commented:

*“I think the campus has gained a whole lot more in terms of those commonalities that we have across projects than just paying a fee to some service provider to provide us with a service. So we witnessed a lot of that common talent in terms of exchange of ideas and people talking about how to do things in various committees and so on. So that part of it I think is strategic although I am not quite sure that people clearly saw that path, saying that if we invest in something like this down the road we’ll have all of these other bits and pieces.”*

#### Administrative Dilemmas

##### *To Contribute or not to Contribute*

In the early days when TEU was experimenting with OSLMS, there was no clear policy regarding to what extent they should or should not contribute to external communities. In those days, the TEU staff was very active in making contributions to OSLMS community. However, as eLMS getting more established later on, TEU administrators got increasingly concerned about this issue. For example, not all code that TEU worked on is contributed back to the OSLMS:

*“If we did a major overhaul or just rewrote the file management system, we won’t release that back to the community simply because, we certainly understand the intellectual property of this piece of code should belong to the campus.”*

But the side effect of this approach is that the next OSLMS release would trigger more work in order to merge the TEU customization back to the new version of OSLMS. In other words, by holding the code and not release back to the community may cost TEU more in the long run. It is explained:

*“Because the more you customize, the next time you want to upgrade, when you’re into a new version of OSLMS, you can’t just upgrade to what the new OSLMS community says is OSLMS. You’ve got all these dependencies and customizations that you have to make sure they work. Now you have to re-customize all of these things.”*

TEU also developed policy to prevent staff to engage OSLMS forums during office hours.

*“In the early days, I participated in OSLMS forum for outreach reasons, we encountered a lot of stability problems and we really need help. So it started for work purposes, not*



*for personal gain. But later on, people noticed that I gained too much visibility in OSLMS community, so now we had a policy that doesn't allow forum participation during office hours, so I have to use my spare time to do it instead."*

The administration also becomes more conscious about safe-guarding the financial interests of TEU and AAU.

*"Speaking of revenue, one of our staff members is extremely generous and was making a lot of visits to other campuses to spread the word of OSLMS. And you can put a price on that. At \$300 a day it looks like you just gave away \$4000 worth of work. And some of our needs on our own campus are not being met. So I said, we have to stop that, and if they want you to come then we will set up a costing structure for what we will charge internally for consultations and what we charge externally."*

### **Staff Retention**

Currently, TEU is also facing some challenges in retaining staff. Some skilled staff members left for better paying jobs, as it is explained:

*"We lost seven people in seven weeks this summer. And the other manager and I, who oversees this group, we talked about having posttraumatic stress disorder because when anybody would ask to meet with us privately, we were afraid that they were going to resign..."*

According to the TEU administrator, the main trigger of loss of key personnel is because the skilled TEU staff is significantly underpaid. It is commented:

*"I mean, one person that left was making \$27,000 a year when I came in. And I got him up to \$50,000 but then he still left for a \$72,000 a year job which is what his market rate is. He deserves to make \$70,000."*

But on the other hand, in terms of timeframe, the loss of staff was also correlated with the fact that a key OSS champion left TEU for a different job. It is commented:

*"[The new manager] really works magic in keeping his staff there because most of it is a lot of loyalty to him. I think that a lot of the people who left had a certain loyalty to [the manager who left]. And I think that is interesting to see the wave that left were a wave that had come in with [the manager who left] and a wave that is still hanging on that I'm really fighting to keep are a wave that came in with [the new manager]. So I think there is a certain loyalty there."*

## **DISCUSSION AND CONCLUSION**

It appears that overall the project of incorporating an OSS project to run a Learning Management Systems is a success. However, there are a handful of important lessons that have come out of this analysis.

First, the process of using an OSS project to run an internal service is a complex process, which may appear to be simple due to the lack of a purchase price. The decision to run a service in-house based on source code and in-house expertise is very much like the decision to buy vs. build. Both short-term viability and long-term sustainability have to be considered. It is a fine balance between paying for a recurring service to an off-campus agency vs. building in-house intellectual capital. Second, the methodologies that surround OSS projects may be ad-hoc and implicit, but are nevertheless methodologies, and often get ignored by managers who are trained on the proprietary side of software development. OSS projects do not lack a methodology - they simply have different methodologies that need to be recognized and managed accordingly. This is evident in the diverging perspectives of the managers and the developers. This gap can perhaps be reduced by the management's improved knowledge of how collaborative open source projects work. Additionally, it would help them in understanding why continuous contribution to the external source project is vital for the long term sustainability of such efforts. The third lesson has to do with the integration of a service with other services, where there are economies of scale and scope to be leveraged if the organization makes wise choices of software with similar underlying pieces. For instance, it will be advantageous for this campus to leverage Linux, Apache, MySQL and PHP related expertise across multiple services.

The service units would also benefit from a way to monetize their expertise through consulting services. Additional revenue could be used to compensate the staff in different ways, thereby improving staff morale.

Migrating to a new platform is challenging in any organization. An OSS project brings complexities of cadence and features that may be difficult to synchronize with. It takes a well-organized institution-wide strategy to organize resources, and leverage scope and scale across different platforms to serve different stakeholders across the institution.

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