Optimization of LMS for Improving User Response Time

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LMS
Moodle
Problem Statement
edX
Conclusion and Future work
Part I

Learning Management System
Comparison

Classroom Training
- Instructor-led
- Instructor and learners

Traditional

e-Learning via The Internet

Benefits of e-learning versus traditional classroom settings:
- Learner-centered
- Instructor and learners (plus external experts)
- Interaction between learners

Interaction between learners can be more lively in e-Learning via the Net than in conventional group training.
The following features are required for LMS in an e-learning process.

- Modular structure
- Discussion forums, group work
- Video conferencing support
- Online exam, exam module
- Chat, wiki, survey, search, Whiteboard
- Backup support
- XML support to work with different systems
- Multiple language support
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Basic functionalities of every LMS

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2. Commercial LMS’s are Blackboard, Desire2Learn, ANGEL Learning Management Suite, KEWL, and eCollege.
Types of LMS

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<tbody>
<tr>
<td><strong>1. Learner Tools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.1 Communication Tools</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion Forums</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Discussion Management</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>File Exchange</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Internal Email</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Online Journal/Notes</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Real-Time chat</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Video services</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
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<tr>
<td>whiteboard</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td><strong>1.2. Productivity Tools</strong></td>
<td></td>
<td></td>
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<tr>
<td>Book Marks</td>
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<td>N</td>
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<tr>
<td>Calendar/Progress review</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Orientation/Help</td>
<td>Y</td>
<td>Y</td>
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<td>Searching Within Course</td>
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<tr>
<td>Work Offline/Synchronize</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td><strong>1.3 Student Involvement Tools</strong></td>
<td></td>
<td></td>
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<tr>
<td>Group work</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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<tr>
<td>Student Community Building</td>
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<td>Y</td>
<td>Y</td>
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<td>Student Portfolios</td>
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<td>Total available feature</td>
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<td>Total missing features</td>
<td>1</td>
<td>1</td>
<td>2</td>
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<td><strong>2. Support Tools</strong></td>
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<td></td>
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<tr>
<td><strong>2.1 Administration Tools</strong></td>
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<tr>
<td>Authentication</td>
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<td>Y</td>
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<tr>
<td>Course authentication</td>
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<td>Y</td>
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<tr>
<td>Hosted Services</td>
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<td>Registration Integration</td>
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<td><strong>2.2 Course Delivery Tools</strong></td>
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<tr>
<td>Test types</td>
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<td>Automated testing Support</td>
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<tr>
<td>Course Management</td>
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<td>Online Grading</td>
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<td>student tracking</td>
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<tr>
<td>Accessibility Compliance</td>
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<td>content sharing /reuse</td>
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<tr>
<td>course templates</td>
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<td>Customized Look and Feel</td>
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<td>Instruction Design</td>
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<td>Y</td>
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<td>Instructional standards compliance</td>
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<td><strong>3. Technical Specifications</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td><strong>3.1 Hardware/Software</strong></td>
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<tr>
<td>Client Browser required</td>
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<tr>
<td>Database Requirements</td>
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<td>Y</td>
<td>Y</td>
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<tr>
<td>Unix Server</td>
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<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Windows server</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td><strong>3.2 Pricing/Licensing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Company profile</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Costs</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
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<tr>
<td>Open source</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
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<tr>
<td>Optional extras</td>
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<td>Y</td>
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<tr>
<td>Total features</td>
<td>8</td>
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We can conclude that Moodle and edX support almost all features compared to commercial software.

Moodle LMS does not support bookmarking and company profile.

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2. Moodle LMS does not support bookmarking and company profile.

3. If we add these features, then Moodle will work in more productive way.
Part II

Moodle LMS
Main goal of our project is to improve the user response time. According to our institute Moodle system administration team, who conducted so-many courses with the following configuration:

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**Table:** DBP Moodle System Configuration

- Moodle does not have any problem up to 2,500 users.
- When they doubled users, performance issues of Moodle came into picture.
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- Standard Moodle Functionalities
- Plugins
- Database
  - Server Architecture
  - Tables classification
Outline Moodle LMS

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Moodle Introduction

- Moodle is used for primary and secondary schools, non-profit organizations, hospitals, private companies, libraries.
- Standard Moodle includes core Moodle modules and different types of plugins.
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  - Users
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Core of Moodle

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Major Moodle Functionalities

- Assignment Submission
- Discussion Forums
- File Download
- Grading, Chat, Wiki, Online Calendar
- Online news and announcement (College and course level)
- Conducting online quiz
- Multi language support
- Modular, i.e., can be extended by creating plugins
- Report (Which can be used for tracing or analyzing the user logs)
Users in Moodle

The following users access Moodle with their authentication level:

- **Administrator (100%)**
- **Course creator (75%)**
- **Teacher (50%)**
- **Non-editing teacher (40%)**
- **Student (25%)**
- **Guest (10%)**

*Figure: User Authentication Levels [AAZ08]*
Entire Moodle LMS contains 1.488 Million Lines of Code

Organization of code follows transaction script approach
Classification of Moodle plugins

- Activities: The main student activities in a course
- Users: managing users
- Reports: administrators, teachers and general users.
- Grade book
- Cache
Admin tools: Provides utility scripts useful for admins to examine and modify a Moodle site

- Blocks: add to courses or home pages
- Themes: change look and feel of your site or course
- Course formats: Change the structure (or) layout of course pages
- Filters: can process and change text
- General plugins
- Editors
- Plagiarism
Classification of Moodle plugins (Cont..)

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Moodle database

- Moodle Database support MySQL, PostgreSQL, SQLite, and Oracle. In our case, we are using MySQL.
- Moodle database schema contains 314 tables.
- These tables is contain core database tables, and plugin tables.
- The Moodle database structure is defined in install.xml files inside the db folder in each plugin.
- Uses XML for updating Moodle database
- Moodle uses InnoDB storage engine as default one.
- Moodle 1.9 or earlier versions are using MYISAM storage engine
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Moodle database server architecture
Classification of database tables

- Activity Modules
- Courses
- Groups
- Grade Book
- Question Bank
- Statistics
- Backup and restore
- Users and Profiles
- Roles and Capabilities System
- Blocks
Classification of database tables (cont..)

- Question Types
- Configuration
- Logging System
- Blocks System
- Moodle Network
There are two kinds of profiling; those are used for finding the performance bottlenecks of Moodle database.

1. Application Profiling
2. Server Profiling

We can find out where database server spends most of the time by using server profiling. MySQL server has two kinds of query logs.

- General query log
- Slow query log
General query log

All queries which are received by the server, and queries that may not be even executed once due to some error. It means, whatever server receives those recorded in general query log.

Slow query log

It will helpful for optimization, because it contains queries which are taking long time to execute. Also it will record only successful executed queries.

The slow log file contains following metrics,

1. Query time
2. Lock time
3. Rows sent
4. Rows examined
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Part III

Performance Testing Tools
In this project, the following performance testing tools are going to use for finding the bottlenecks of Moodle database server,

- Jmeter
- mk-query-digest
- mysqltuner
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1. Jmeter
2. mk-query-digest
3. mysqltuner:

   Analyzes your database server performance and, based on the statistics it gathers, gives recommendations which variables you should adjust in order to increase performance.
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2. mk-query-digest
3. mysqltuner:
   Analyzes your database server performance and, based on the statistics it gathers, gives recommendations which variables you should adjust in order to increase performance.
Part IV

Project Plan
We are planning to find the bottleneck of the database server. Every year, IIT Bombay conduct the ten thousand teachers program for that they are using the Moodle for conducting the exams. Based on those peek time log results, we will identify bottleneck of database server.
MOOC does not give any idea on how many number of users concurrent users, it will support, time limit.

We will investigate, how many number of concurrent users edX platform will support. For this reason we are going to study some basic functionalities, modules, and database.
Part V

edX
Outline edX-Platform

- Introduction
- Major edX functionalities
- Main Modules
- Database
edX is a non-profit organization which is formed by the collaboration of Harvard and MIT.

- edX organization provides certification
- It is providing various assessment strategies like:
  - Peer assessment
  - Staff assessment
  - Instructor assessment
  - Artificial Intelligence assessments
- edX is available on Github website
- edX consist of Modular structure
- It is developed in Python
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edX Architecture[edx]

edX Platform

codejail
LMS submits python code for secure execution

Output is returned

LMS pushes assessments

ORA (Open Response Assessor)
ORA pushes graded assessments

xqueue
xqueue pushes open-ended assessments

xserver
xserver pushes graded assessments

Grading

Staff Grading

Peer and Self Grading

AI Grading (ease)

Discussion Forums

cs_comments_service (for discussion forums and polls)

Discussions are displayed

Discussions are added

Instructor creates a course in CMS and can start a discussion
The following modules are basic modules[edxa] for edX

1. edX Platform
2. edX-ORA
3. codejail
4. xqueue
5. cs_comment_service
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edX database system uses Sqlite and MongoDB

1. edX database system uses Sqlite and MongoDB
2. It is built on python framework known as django
3. Sqlite stores user information
4. MongoDB is used to store course information; it is document-oriented database
edX Database

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Part VI

Conclusion and Future work
Conclusion and Feature Work

**Conclusion**

- We did features comparison of LMSs.
- Studied in detailed structure of Moodle functionalities, plugin classifications, database server architecture, database tables.
- Some performance testing time frame and its usage and performed some preliminary experiments (Shown in next few slides).
- Basic literature survey on edx which includes edx modules, edx database, technologies used in edx.

**Future work**

- In next one or two months, we will find out database server performance bottlenecks, and we will resolve it.
- Later, we will investigate scalability of edx.
Conclusion

We did features comparison of LMSs. Studied in detailed structure of Moodle, functionalities, plugin classifications, Database server architecture, database tables. Some performance testing tool details and its usage, and performed some preliminary experiments (Shown in next few slides). Basic literature survey on edX which includes edX modules, edX database, technologies used in edX.

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Moodle can be operated by only IT experts [Joh13]
While installation time, users need to know the minimum technical terminology
Most of the Moodle communities are in English language only.
It requires course manager
Moodle database server and webserver need to maintain separately otherwise, it leads to database crash (or) security problems [AAZ08]
Database table index occupies more space compare to actual data in small number of user database.
Thank You
## Preliminary analysis (Moodle Database Tables)

<table>
<thead>
<tr>
<th>RAM</th>
<th>4GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>Intel Core i3-2370M</td>
</tr>
<tr>
<td>Operating System</td>
<td>Ubuntu 12.04 LTS</td>
</tr>
<tr>
<td>Hard Disk</td>
<td>320GB</td>
</tr>
</tbody>
</table>

1. We had conducted one quiz on both LMS’s which consists of 2 questions those are Multiple choice question and short answer question.
2. It is accessed 46 tables.
3. System Configuration.
The edX platform consist of total 88 tables including django’s tables.
Out of these, django database consist of total 11 tables in edX
### Database Tables classifications

1. Authentication
2. Bulk_emails
3. Celery
4. Certificates
5. Circuit
6. Course
7. Courseware
8. Djcelery
9. Licenses
10. Notify
11. Shopping Cart
12. Tracking
13. Verify
14. Student
15. Wiki
Error reading from database

**Figure:** Moodle Database crash
1. We had conducted one quiz on both LMS's which consists of 2 questions those are Multiple choice question and short answer question.

2. It is accessed 10 tables.
### edX tables

<table>
<thead>
<tr>
<th>Table Name</th>
<th>No. of Times Table Accessed</th>
</tr>
</thead>
<tbody>
<tr>
<td>courseware_studentmodule</td>
<td>56</td>
</tr>
<tr>
<td>auth_group</td>
<td>38</td>
</tr>
<tr>
<td>Django_session</td>
<td>33</td>
</tr>
<tr>
<td>courseware_xmodulecontentfield</td>
<td>19</td>
</tr>
<tr>
<td>courseware_xmodulesettingsfiled</td>
<td>19</td>
</tr>
<tr>
<td>Auth_user</td>
<td>10</td>
</tr>
<tr>
<td>student_courseenrollment</td>
<td>6</td>
</tr>
<tr>
<td>certificates_generatedcertificate</td>
<td>1</td>
</tr>
<tr>
<td>external_auth_externallauthmap</td>
<td>1</td>
</tr>
<tr>
<td>auth_userprofile</td>
<td>1</td>
</tr>
</tbody>
</table>

**Table:** list of edX database tables accessed for quiz
Tools

---

**Figure:** mysqltuner tool

---

---

**Figure:** httpload tool

---

raju@raju:/moodle/http_load$ ./http_load -rate 5 -seconds 10 url.txt
47 fetches, 9 max parallel, 4.18427e+06 bytes, in 10 seconds
89027 mean bytes/connection
4.69999 fetches/sec, 418426 bytes/sec
msecs/connect: 6.99551 mean, 85.356 max, 1.293 min
msecs/first-response: 250.267 mean, 456.218 max, 202.127 min

**Figure:** httpload tool
References I


References III

