The LON-CAPA Shared Content Pool

Warning: Presentation constantly rewritten over the course of the day as I listened to other speakers.

Gerd Kortemeyer
Michigan State University
Experiences

• The whole conference is about sharing content
• No sense preaching to the choir
• Thus: LON-CAPA

The Free Open-Source Distributed Learning Content Management and Assessment System

• What have we learned in 19 years?
Focus on online educational resources for learners

- Not on research publications
- Not on guides on how to teach better
- Not digital versions of books
- Not collections of materials for lecture preparation
- Not data collections (except for learners to evaluate as part of their learning)
Experiences

- Focus on large enrollment introductory undergraduate courses and AP courses at schools
  - online
  - hybrid
  - online supplement or textbook replacement for traditional lectures
Sharing of Resources

• Educators are about educating
  ▪ That’s why they chose their job
  ▪ They are motivated by things that help them teach effectively
  ▪ But they don’t have infinite time

• Digital repositories/libraries/resource pools/… are about sharing of resources
  ▪ Goal: efficiently share effective teaching resources
The key to re-usability is to create course-context free resources.
In other words, same resource can be used in different contexts.
This means:
- No button “next resource”
- No button “back to course menu”
- No wording such as “as we have previously seen”
- etc
Sharing of Resources

- Counter-Example:

  Pre-fabricated complete courses
Sharing of Resources

• But wait!

Just a random collection of more pre-assembled stuff
Sharing of Resources

• Counter-Example:

An Introduction to Capacitance
This is an interesting tutorial to capacitors. It includes the definition, a brief history and principle behind the working of a capacitor. A description to application of capacitors is given too.

Keywords: Capacitance, Electricity & Magnetism, Electrostatics, Physics, Science, Science Physics, applets for capacitance, capacitance, capacitors, electricity, electrostatics, physics, simulations for capacitance

http://micro.magnet.fsu.edu/electromag/electricity/capacitance.html

View all related information
Sharing of Resources

Branding

Another search

Different navigation

Plenty of ways to get off-topic

No link back
Sharing of Resources

• Way-off topic

Digital libraries that are basically catalogued link collections are no better than “surfing the web”
Sharing of Resources

- You might as well:

  - Actually pretty good!

  - Same as NSDL

  ![Google Search for Capacitance](#)

  - Capacitance - Wikipedia, the free encyclopedia
    In electromagnetism and electronics, capacitance is the ability of a body to hold an electrical charge. Capacitance is also a measure of the amount of... Capacitors - Coefficients of potential - Self-capacitance - Elastance
    en.wikipedia.org/wiki/Capacitance - Cached - Similar

    Capacitor - Wikipedia, the free encyclopedia
    Jump to Instability of capacitance: The capacitance of certain capacitors decreases as the component ages. In ceramic capacitors, this is caused by...
    en.wikipedia.org/wiki/Capacitor - Cached - Similar

  - Capacitance
    Capacitance is typified by a parallel plate arrangement and is defined in... you get by calculating the equivalent capacitance of the series combination...
    hyperphysics.phy-astr.gsu.edu/hbase/electric/capac.html - Cached

  - Molecular Expressions: Electricity and Magnetism - Capacitance
    This section of the Electricity and Magnetism Primer provides a thorough discussion of electrical capacitance. It contains several Interactive Java...
    micro.magnet.fsu.edu/electromag/electricity/capacitance.html - Cached - Similar
So, what is the point of a digital library/repository/resource pool for education?
Sharing of Resources

• Need value-added features beyond
  ▪ catalogues and
  ▪ community functions
  which usually remain unused anyway

• Particularly for educational libraries:
  Provide infrastructure for using resources
  in educational contexts
• How do you use context-free re-usable resources in the context of a course?
• The system **dynamically** generates context for context-free resources:
  ▪ Navigation (no getting lost!)
  ▪ Contextual community functions
  ▪ Feedback to instructors and authors
• Instructors and students are different!
  ▪ Instructors select content that students get
  ▪ Instructors customize the content
• In our environment (large enrollment undergraduate courses), you need an infrastructure to
  ▪ Find resources in a library of resources
  ▪ **Sequence them up** (put the puzzle together)
  ▪ Serve them out to the students
• Example: LON-CAPA
LON-CAPA Architecture

- Instructor Computer
- Student Computer
- Campus A
- Campus B
- Campus C
- Interserver
- Web
- Inter-Institutional Network of Servers Connecting Universities and Schools
LON-CAPA Architecture

Course Management

Campus A

Resource Assembly

Campus B

Course Management

Resource Assembly

Shared Cross-Institutional Digital Resource Library
- The distributed network looks like one big file system
Resources may be web pages ...

Impedance

The addition of the three currents (through the resistor, the inductance, and the capacitance), each of which is 90° out of phase with each other, in quadrature yields:

\[
V = \sqrt{V_R^2 + (V_C - V_L)^2} = \sqrt{(1 R)^2 + (X_C - X_L)^2} = I \sqrt{R^2 + (X_C - X_L)^2} = I Z
\]

where I is the current, \(X_C\) and \(X_L\) are the capacitive and inductive reactances, respectively, and Z is the impedance. Putting in the values of the reactances, we obtain for Z:

\[
Z = \frac{V}{I} = \sqrt{R^2 + (X_C - X_L)^2} = \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2} = \sqrt{R^2 + \left(\frac{1}{2\pi f C} - 2\pi f L\right)^2}
\]

and has its minimum of \(Z = R\) when

\[
\omega_0 = (LC)^{-1/2}
\]

where LC circuit. This is the resonance frequency of the RLC circuit. The reactance and of the resonant frequency is shown in the figure.

Some LC circuits give to be added in a special way. They end up as a single quantity \(Z\), the result of the reactance.
Shared Resource Library

• ... or simulations and animations ...

Animation speed:
- faster
- medium
- slower

Play animation number:
1 2 3 4 5 6 7 8 9
• … or this kind of randomizing online problems

A crate with a mass of 155.5 kg is suspended from the end of a uniform boom with mass of 89.5 kg. The upper end of the boom is supported by a cable attached to the wall and the lower end by a pivot (marked X) on the same wall. Calculate the tension in the cable.
LON-CAPA Architecture

Campus A

Course Management

Resource Assembly

Campus B

Course Management

Resource Assembly

Shared Cross-Institutional Digital Resource Library
Resource Assembly

- Take shopping cart to the supermarket
Resource Assembly

- Nested Assemblies
- No pre-defined levels of granularity ("module", "chapter", etc)
  - People can never agree what those terms mean
- Re-use possible on any level
  - Customize your table of contents
Resource Assembly

Writes module about energy conservation

Compiles module about conservation laws

Writes module about momentum conservation

Uses whole assembly in his course
LON-CAPA Architecture

Course Management

Campus A

Resource Assembly

Campus B

Resource Assembly

Shared Cross-Institutional Digital Resource Library
Course Management
Course Management

- Posting of materials
- Posting of homework
- Discussions
- Announcements
- Portfolios
- Scheduling
- Gradebook
- ...

![Image of a person sitting at a desk with stacks of papers]
Course Management

- Instructors can directly use the assembled material in their courses
  - navigational tools for students to access the material
  - access rights management
  - timing
  - contextual discussions and messaging
Assembled structure turns into the course navigation

Organized around the content, not the resource type, e.g. embedded assessment
### Course Management

- Course overview/dashboard

### Course Action Items

**Go to first resource**
Page set to be displayed after you have selected a role in this course. Currently: *What's New? page (user preference)*  **Change** for just this course or for all your courses.

#### Problems requiring handgrading

<table>
<thead>
<tr>
<th>Problem Name</th>
<th>Number ungraded</th>
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<tr>
<td>Electric Field</td>
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#### Problems with errors

No problems with errors

#### Problems with av. attempts ≥ 3 or deg. difficulty ≥ 0.8 and total number of students with submissions ≥ 4

<table>
<thead>
<tr>
<th>Resource</th>
<th>Part Num. students</th>
<th>Av. Attempts</th>
<th>Deg. Diff</th>
<th>Last Reset</th>
<th>Reset Count</th>
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<tbody>
<tr>
<td>Field Lines</td>
<td>single part</td>
<td>24</td>
<td>2.12</td>
<td>0.84</td>
<td></td>
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<tr>
<td>Net Force</td>
<td>single part</td>
<td>53</td>
<td>2.49</td>
<td>0.80</td>
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<tr>
<td>Pith Balls</td>
<td>single part</td>
<td>52</td>
<td>4.12</td>
<td>0.90</td>
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#### Unread course discussion posts

<table>
<thead>
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<th>Type</th>
<th>Time of last post</th>
<th>Number of new posts</th>
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<td>Coulomb</td>
<td>Resource</td>
<td>last Monday, Jan 16 at 04:55 pm (EST)</td>
<td>1</td>
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<td>Distance Change</td>
<td>Resource</td>
<td>last Monday, Jan 16 at 07:00 pm (EST)</td>
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<td>Field Lines</td>
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<tr>
<td>Force</td>
<td>Resource</td>
<td>on Wednesday, Jan 11 at 07:01 pm (EST)</td>
<td>3</td>
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<td>Net Force</td>
<td>Resource</td>
<td>23 hours, 19 minutes ago</td>
<td>5</td>
</tr>
<tr>
<td>Pith Balls</td>
<td>Resource</td>
<td>last Monday, Jan 16 at 09:21 pm (EST)</td>
<td>6</td>
</tr>
<tr>
<td>Point P</td>
<td>Resource</td>
<td>last Friday, Jan 13 at 02:34 pm (EST)</td>
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<tr>
<td>Potential</td>
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<td>last Sunday, Jan 15 at 03:15 pm (EST)</td>
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<td>Vectors</td>
<td>Resource</td>
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#### Resources in course with version changes since last week

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<th>New version</th>
<th>Version used</th>
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<td>Capacitation of a Sphere</td>
<td>Mon Jan 16 12:03:13 2006</td>
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#### New course messages

No unread critical messages in course
Isn't that rather monolithic?
Dynamic Metadata

Advantage:
• Feedback from all levels
• The system gets to know the resources
Dynamic Metadata

- Dynamic metadata from usage
- Assistance in resource selection ("amazon.com")
- Quality control

Access and Usage Statistics

| Network-wide number of accesses (hits) | 890 |
| Number of resources using or importing resource | 1 |
| Number of resources that lead up to this resource in maps | 1 |
| Number of resources that follow this resource in maps | 1 |
| Network-wide number of courses using resource | 3 |

Assessment Statistical Data

- Total number of students who have worked on this problem: 291
- Average number of tries till solved: 1.37
- Degree of difficulty: (0.36)
Dynamic Metadata

• More useful than static metadata

• Authors
  ▪ spend hours writing beautiful resources
  ▪ do not spend five minutes to fill out even the most basic information

• Dynamic metadata shows the resource “in action”
The LON-CAPA Community

• Does this work?
• Does it scale?
Shared Resource Library

LON-CAPA Shared Resource Pool, Summer 2010

- **Total**
- **Problems**
- **Pages**
- **Images**
- **Libraries**
- **Assemblies**
- **Movies/Sound**
- **Animations/Simulations**
- **Other**

Shared content repository with over 400,000 resources

Almost 180,000 online homework problems
The LON-CAPA Community

130 member institutions
The LON-CAPA Community

High Schools, Colleges, and Universities

USA: 108
Canada: 7
Germany: 3
Turkey: 1
Israel: 2
South Korea: 1
South Africa: 1
Brazil: 2
Switzerland: 1
Great Britain: 1

... plus grant projects and publishing companies.
The LON-CAPA Community

- Cross-institutional use

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</tbody>
</table>
The LON-CAPA Community

- Creates communities of practice!
- Connects colleagues doing the same thing
- Annual conferences and workshops

Legend:
- ▲ - members of SAC 1 and WAC 6
- ▼ - members of SAC 2 and WAC 6
- △ - members of WAC 6
The LON-CAPA Community

- Driving force: problems

![Math problem]

What is the derivative of

\[
\begin{pmatrix} 4t^3 \\ 8t^8 \end{pmatrix}
\]

with respect to \( t \)?

\[4t^{\wedge}2, 8t^{\wedge}7\]

You need to multiply with the original exponent.

Submit Answer Incorrect. Tries 1

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<th>Available</th>
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<th>Instances of being used at institutions</th>
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</table>

<30% reuse

>80% reuse
And how is this sustained?
CAPA has been around since 1992, initially as pure homework/assessment system.

Since 1999: shared repository (“LON-CAPA”)

19 years … with ups and downs
- currently “down” – partner institutions have budget cuts

Components of sustainability:
- financial:
  - staff
  - hardware
  - travel
- ongoing software platform development
- ongoing content contributions
- increasing user community
- scholarship
Lessons learned over 19 years:

• **Have a clearly defined purpose** – even if it precludes some funding “opportunities.” Don’t let money drive you!

• **Be selective about whom you allow to contribute** – but then give them freedom

• **Distribute** – a single institution is too fickle an environment

• **Share the wealth** – help your partner institutions get funding, publicity, etc.
Clearly Defined Purpose

• You cannot be all things to all people
• Do not provide a random hodgepodge of “stuff”
• Otherwise, your users might as well just surf the web
• In LON-CAPA case: the decision makers (instructors) look for tested and trusted resources that they can put in front of their students
Be Selective

Be selective about whom you allow to contribute

In case of LON-CAPA,

• only bona-fide schools, colleges, universities, and publishers can join the network
• only faculty/instructors at participating institutions can contribute content
• crackpots and folks with some random agendas damage your credibility – the agenda is education
Be Selective

• Be selective about whom you allow to contribute – **but then give them freedom**

• In case of LON-CAPA:
  ▪ No explicit peer-review
    • hurdle to contributing
    • bottleneck
  ▪ But: implicit peer-review through dynamic metadata (usage tracking)
  ▪ Another instructor choosing a resource for his or her course is peer-review!
Content Stewardship

• Copyright stays with author (enforceable!)
• Developed before Creative Commons
• Authors can grant “right of use:”
  ▪ public
  ▪ system-wide by instructors for students
  ▪ only within own institution
  ▪ “custom” – very flexible
  ▪ open-source: make derivative works
• Most authors use:
  ▪ system-wide closed-source
Content Stewardship

• Have responsibility for author contributions
  ▪ Enforce licensing
  ▪ Protect integrity of for example exam problems
  ▪ Guarantee that the content remains accessible
LON-CAPA is a “franchise” – local ownership

- For example, at MSU 11,000 student course enrollments per semester running out of LON-CAPA
- UIUC: 9,000 student course enrollments
- SFU, Ostfalia, Ohio U, …

Programmers and support staff paid by the partner institutions as part of their instructional support cost

LON-CAPA development and support tied into universities’ core business
• Distributed at institutions:
  - Programmers
    (open-source software platform)
  - Scholarship
  - Support
  - “Marketing”
Share the wealth

- **Share the wealth** – help your partner institutions get funding, publicity, etc
  - Make platform and content available for free
  - Grants do not need to come to you directly to help
  - Let other institutions do connected scholarship
  - Other people can do marketing for you
Share the wealth

Examples:

• Current EUR 200,000 grant to partner university in Germany – MSU does not get one cent of that directly, but project benefits greatly
• Current and past NSF-ASA and NSF-CCLI grants using LON-CAPA as platform – LON-CAPA benefits
• German university paid for booth at CeBIT exhibit two weeks ago
• Scholars at other universities publishing research papers and opinion pieces about LON-CAPA
• Students at various institutions doing thesis work on LON-CAPA
• School offering paid professional development on LON-CAPA to other schools
• Other universities hosting annual conferences
How to Get Contributions

• Need this for their own teaching, contributions not purely altruistic

• Needs some critical mass of content:
  ▪ If instructors find 80% of what they want for their course, but are missing some concrete things, they might be very willing to just contribute that “missing piece.”
  ▪ Chicken before egg …
How to Get Contributions

- Assurance that any content they generate today is going to keep being available
  - Investment has to pay off when teaching the course again a year, two years, \( n \) years from now
  - Provide security and stewardship for content
  - We still support content written in 1993
  - You are entrusted with that content!
Faculty need to see impact:
- Faculty have some urge to “broadcast”
- They want to see things used

Show authors how many students in how many courses at how many institutions used their stuff
Direct sustainable income stream?

- **Do not want to charge for software**
  - Believe in open-source

- **Do not want to charge the students**
  - Education already expensive enough

- **Micropayment schemes**
  - Too cumbersome
  - Possible conflicts with institutional intellectual property policies
  - Textbook publishers don’t play
  - Educational content has no monetary value: universities sell degrees, not education

- **Do not want to charge for service**
  - Institutions can run LON-CAPA completely for free
Direct Sustainable Income

• Spin-Off: eduCog, LLC

Welcome

Welcome to eduCog, a company providing cost effective, affordable access to quality educational tools and services.

• Who we are
• What we do
  ○ LON-CAPA Hosting, K-12
  ○ LON-CAPA Hosting, Higher Education
  ○ ...
• How we do it
• How to contact us

eduCog, LLC
An Education Service Company
P.O. Box 26, Haslett, MI 48840
eduCog@eduCog.com
Direct Sustainable Income

• Hosting of LON-CAPA for institutions that are unable or unwilling to run their own installation

• Attractive since LON-CAPA is also complete course management system (established cost center)

• Constant income stream from low-cost hosting fees
Direct Sustainable Income

- Textbook Publishers
- Warning: complicated mechanism!
- Publishers sell textbooks. Period.
- Instructors are decision makers for several hundred sales at a time
- Incentives for instructors: free ancillary materials, particularly online homework
Textbook publishers pay spin-off company for

• coding ancillary materials
• hosting ancillary materials
• selectively open up these libraries for courses that adopted the textbook (digital rights management)
• constant income stream: publishers intentionally make problem libraries incompatible between editions
Direct Sustainable Income

- Five major publishers

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<th>Academic Area</th>
<th>Author</th>
<th>Publisher</th>
<th>Edition</th>
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<td>Physics</td>
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<td>WH Freeman</td>
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<td></td>
<td>41 Madison Avenue</td>
<td>New York, NY 10028</td>
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<td></td>
<td><a href="mailto:cmarshall@whfreeman.com">cmarshall@whfreeman.com</a></td>
<td>(212) 561-8204</td>
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Sustainability Summary

• Sustainability is not easy to achieve
• Select exactly what you do and what you don’t do, and do it well
  ▪ Be flexible if odd funding opportunities come up that support your mission
  ▪ Tie into institutions’ core business and established cost centers
  ▪ Don’t let random grant opportunities distract you from your mission – grant funding is nice, but not sustainable
• Create community
• Thank you!
• Gerd Kortemeyer
  Michigan State University
  http://www.lite.msu.edu/kortemeyer/
  korte@lite.msu.edu