LON-CAPA

An Open-Source Learning Content Management and Assessment System

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Overview

Presentation Outline:

- System Overview and Architecture
- Research
- Community

System Overview and Architecture

LON-CAPA Overview

- LON-CAPA is
  - free
  - open-source
  - a learning content management system
  - an assessment system
  - around since 1992

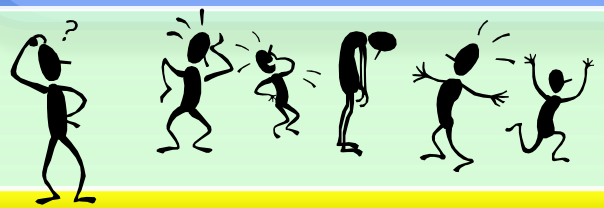
Free and Open-Source

- Free:
  - “Free beer”: no licensing fees
  - “Free speech”: source code, Bugzilla, mailing lists, research results, all out in the open
- Open-source: you can read, modify, improve, adapt, etc, the original code of the system

```
while ($line=<IN>) {
   chomp($line);
   $line=~s/\s+$//s;
   $line=~s/\"//g;
   $line=~tr/A-Z/a-z/;
   @entries=split(/\,/,$line);
   $username=$entries[4];
_
```

- BUT: derivative must be distributed under same license, i.e., GNU General Public License

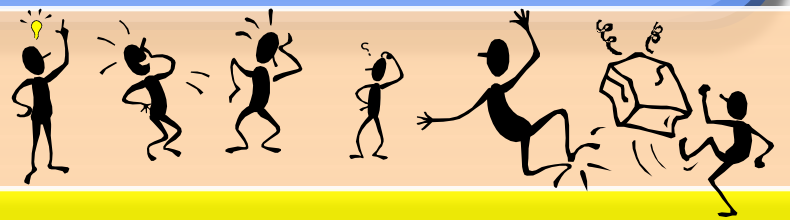
LON-CAPA Architecture



Course Management

Campus A

Resource Assembly
Seleção de conteúdo



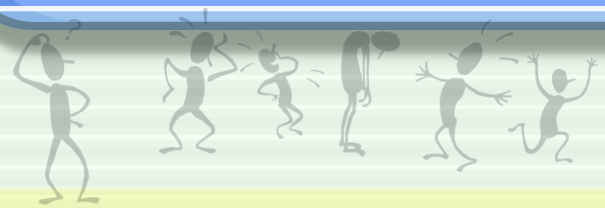
Course Management

Campus B

Resource Assembly
Seleção de conteúdo

Shared Cross-Institutional Resource Library
(Base de Dados Compartilhada entre Instituições)

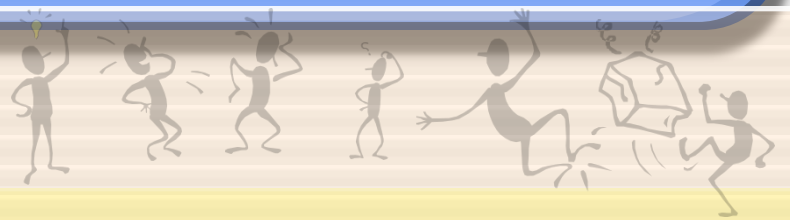
LON-CAPA Architecture



Course Management

Campus A

Resource Assembly



Course Management

Campus B

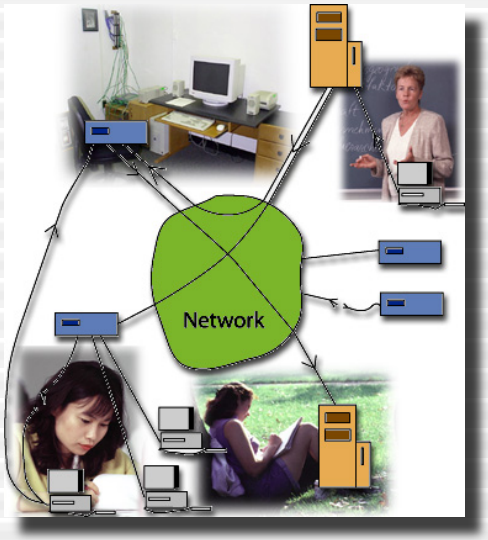
Resource Assembly

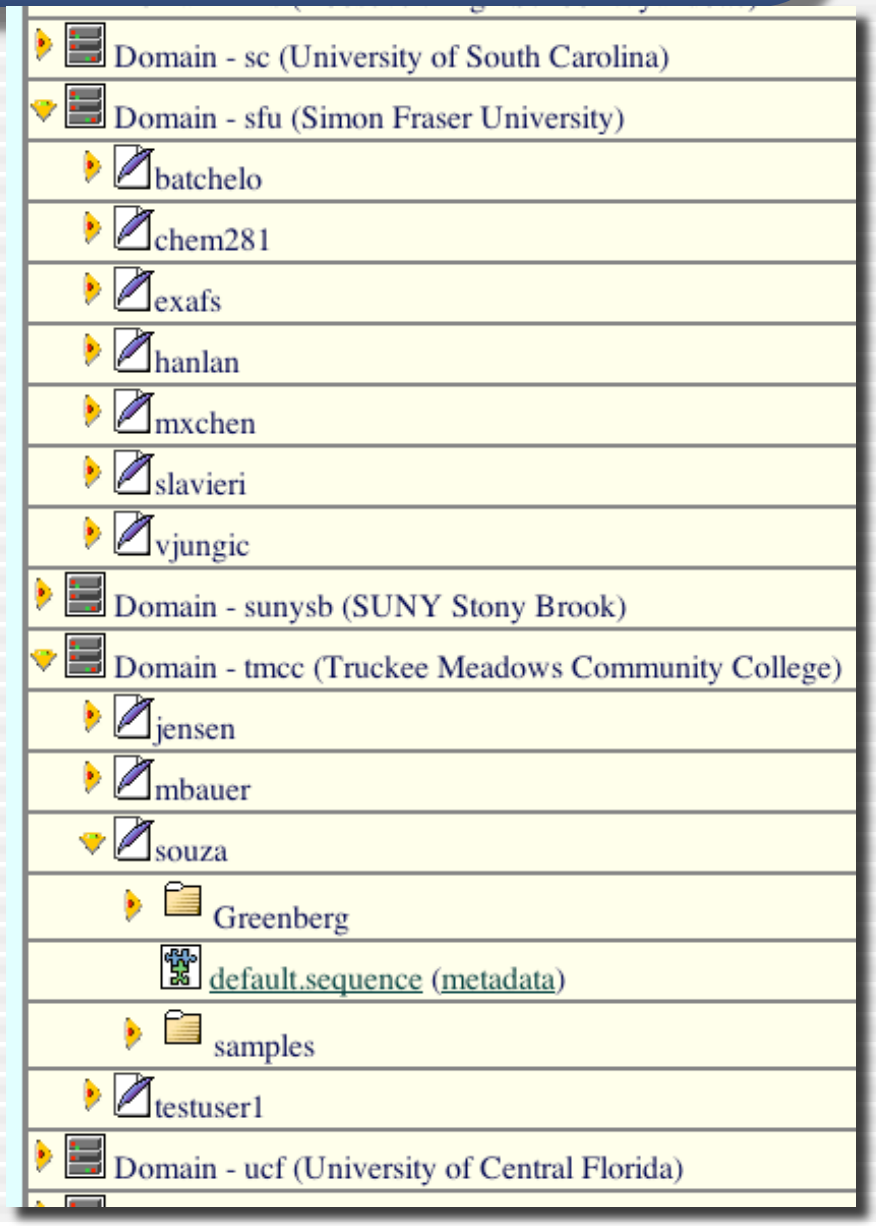
Shared Cross-Institutional Resource Library

(Base de Dados Compartilhada entre Instituições)

Shared Resource Library

- The distributed network looks like one big file system
  (Um conjunto de Instituições interligadas via web funcionando como um único corpo)





Shared Resource Library

- Resources may be web pages …

EXAMPLE

Example: Looping

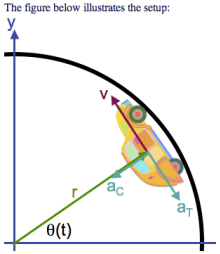
A toy car can go through a looping if it is fast enough. What are the forces that act on it? How fast does it have to be?

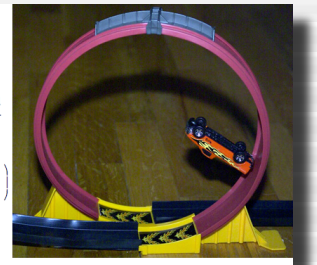
The motion is obviously circular, but non-uniform: the car will slow down on the way up, and speed up on the way down. With r being the radius of the looping, the x-axis horizontal, the y-axis pointing up, the origin being in the center of the looping, and $\theta(t)$ being the angle, the position of the car is given by

$$\vec{r}\,(t) = \begin{pmatrix} r\cos(\theta(t)) \\ r\sin(\theta(t)) \end{pmatrix}$$

as long as it does not fall off the track.

The figure below illustrates the setup:

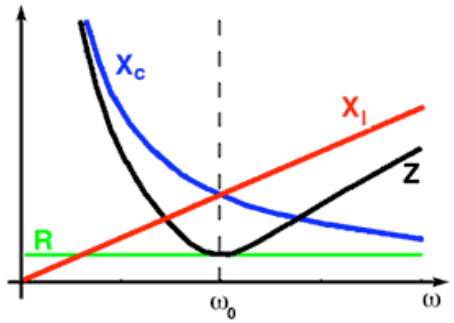




Impedance

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:

$$\begin{aligned} V &= \sqrt{V_R^2 + (V_C - V_L)^2} \\ &= \sqrt{(I\,R)^2 + (I\,X_C - I\,X_L)^2} \\ &= I\sqrt{R^2 + (X_C - X_L)^2} \\ &= I\,Z \end{aligned}$$



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:

$$\begin{aligned} Z = \frac{V}{I} &= \sqrt{R^2 + (X_C - X_L)^2} \\ &= \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2} \\ &= \sqrt{R^2 + \left(\frac{1}{2\pi f C} - 2\pi f L\right)^2} \end{aligned}$$

nd has its minimum of Z = R when

$$\omega_0 = (LC)^{-1/2},$$

pure LC circuit. This is the resonance frequency of the RLC circuit. The dance and of the reactances is shown in the figure.

ave to be added in a special way. They end up as a single quantity Z, the alent of the resistance.

EXAMPLE

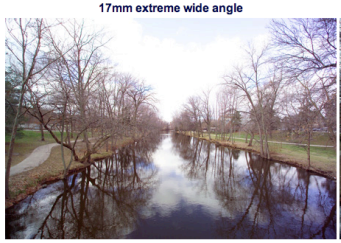
Focal Length

The following pictures are taken from the same vantage point with three different zoom lenses:

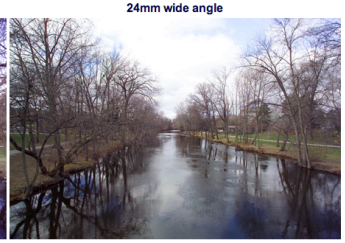
- 17mm-35mm wideangle zoom
- 24mm-70mm normal zoom
- 70mm-300mm tele zoom

using a digital camera with an image sensor of 24mm x 36mm (standard so-called 35mm image format).

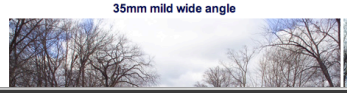
17mm extreme wide angle



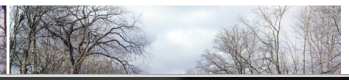
24mm wide angle



35mm mild wide angle

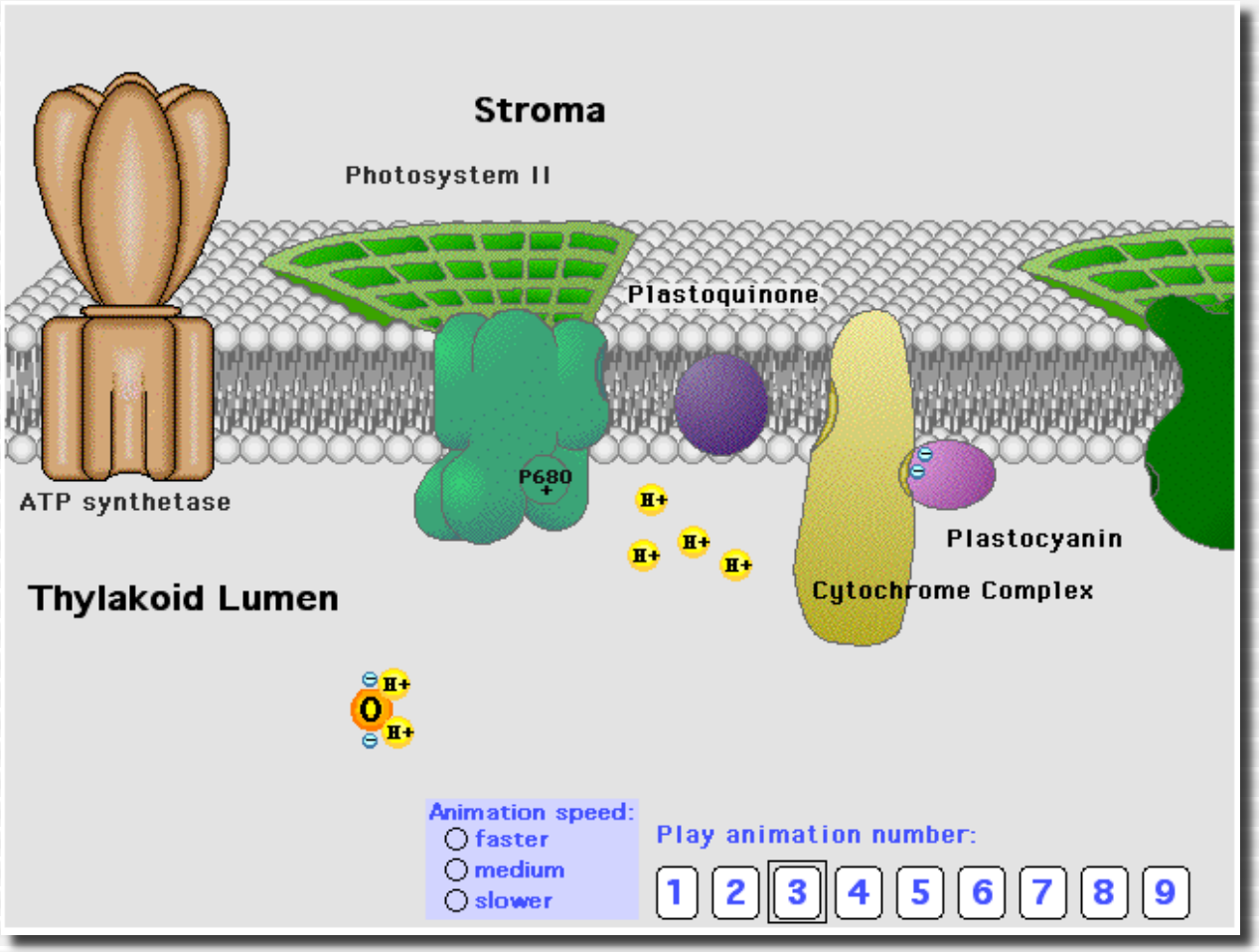


48mm normal



Shared Resource Library

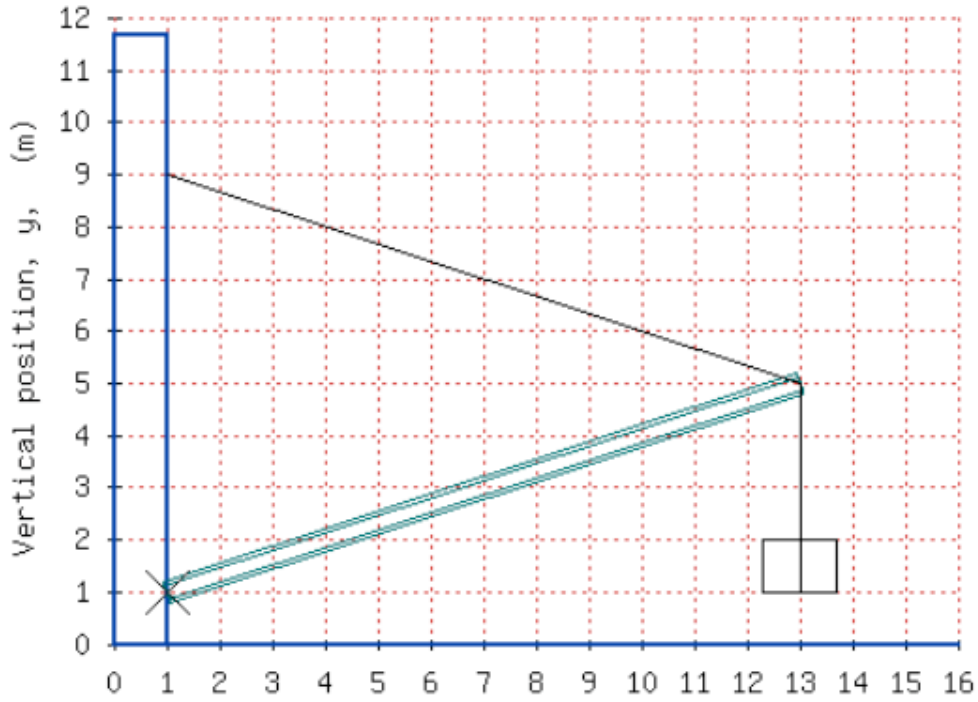
- … or simulations and animations …



Shared Resource Library

- … or this kind of randomizing online problems (distintos problemas gerados online)

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.



Shared Resource Library

- …special emphasis on math
  - including support of
    - LaTeX
    - Maxima
    - R

What is the derivative of

$$\begin{pmatrix} 4t^3 \\ 8t^8 \end{pmatrix}$$

with respect to t? 4t^2,8t^7

You need to multiply with the original exponent.

Submit Answer Incorrect. Tries 1

Give an example of a function

1. which is orthogonal to $6\cdot\cos(7\cdot x)-2\cdot\sin(2\cdot x)$ with respect to the scalar product

$$< g \mid h > = \frac{1}{\pi} \int_{-\pi}^{\pi} dx\, g(x) \cdot h(x)$$

2. whose norm is 1.

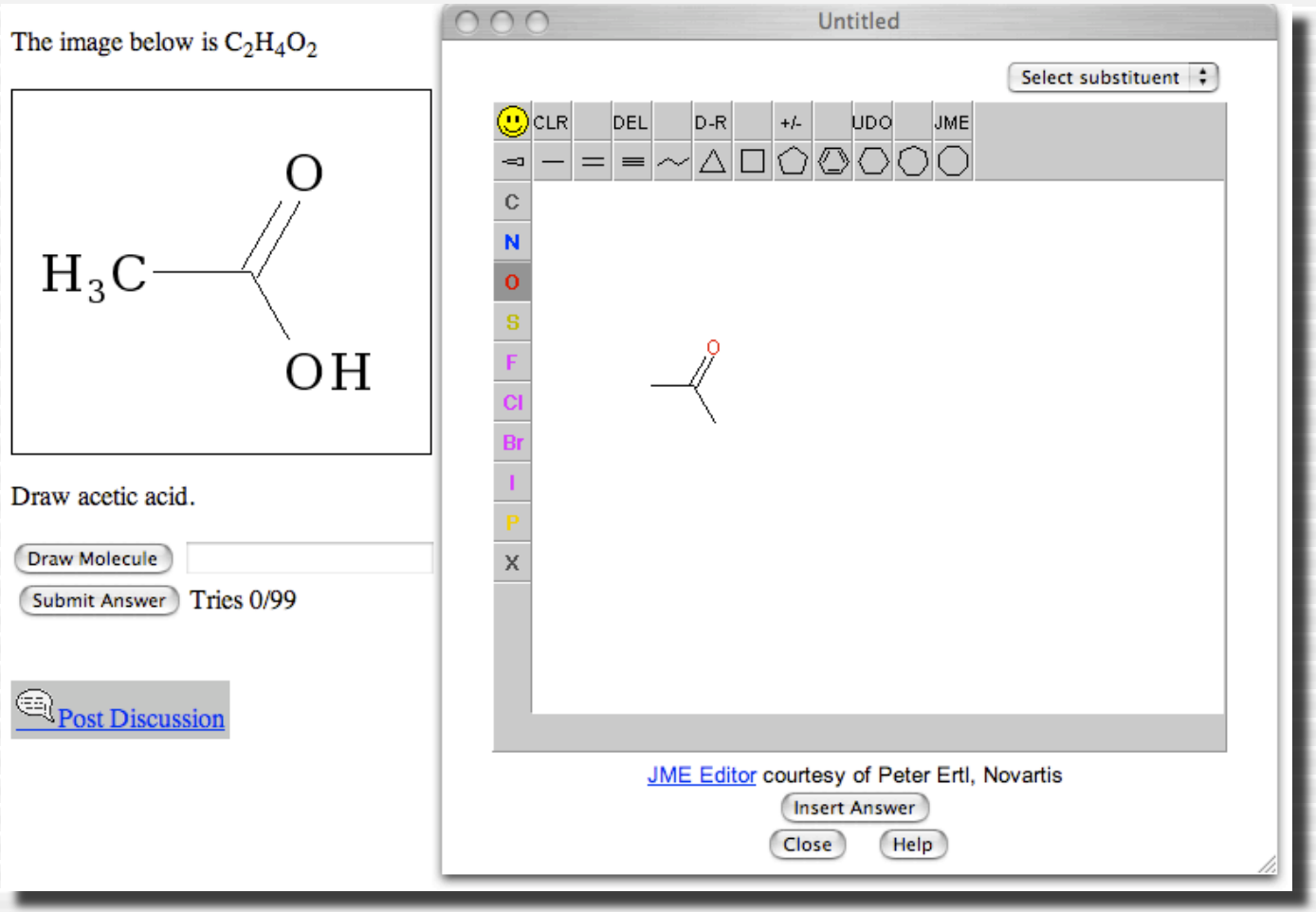
cos(2x)+sin(7x)

The function you have provided does not have a norm of one.

Submit Answer Incorrect. Tries 1

Shared Resource Library

- … chemistry …



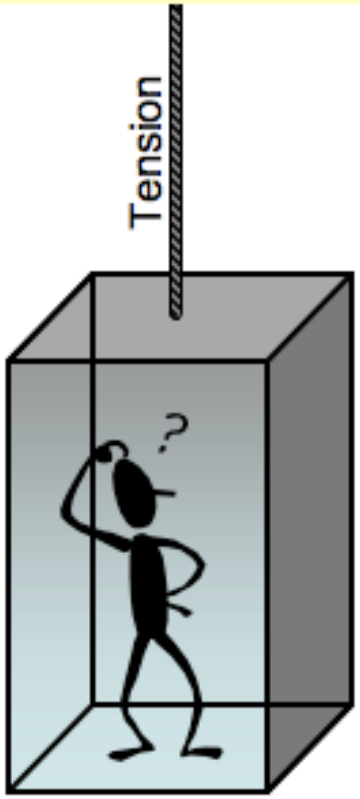
Shared Resource Library

- … physical units …

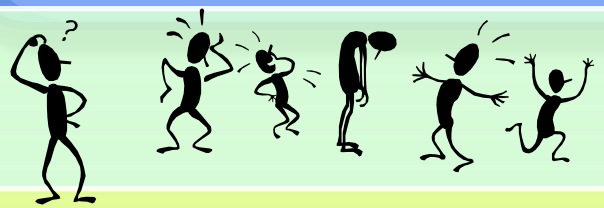
Elevator Problem Due never

An elevator (cabin mass 500 kg) is designed for a maximum load of 2600 kg, and to reach a velocity of 3 m/s in 5 s. For this scenario, what is the tension the elevator rope has to withstand? 32270 kg*m/s^2

Submit Answer Tries 0/99



LON-CAPA Architecture



Course Management

Campus A

Resource Assembly

Course Management

Campus B

Resource Assembly

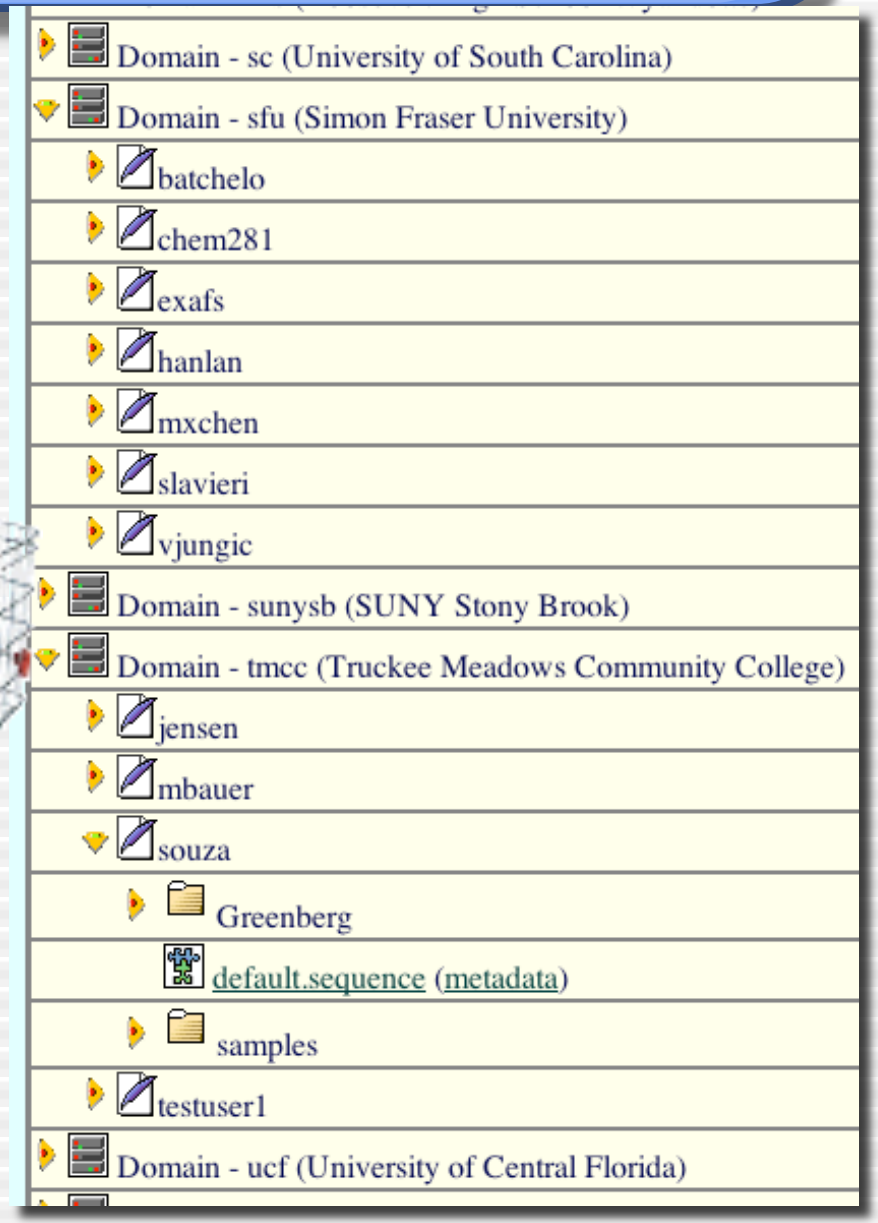
Shared Cross-Institutional Resource Library

Resource Assembly

Selecionando e
Colecionando Conteúdo

- Shopping Cart

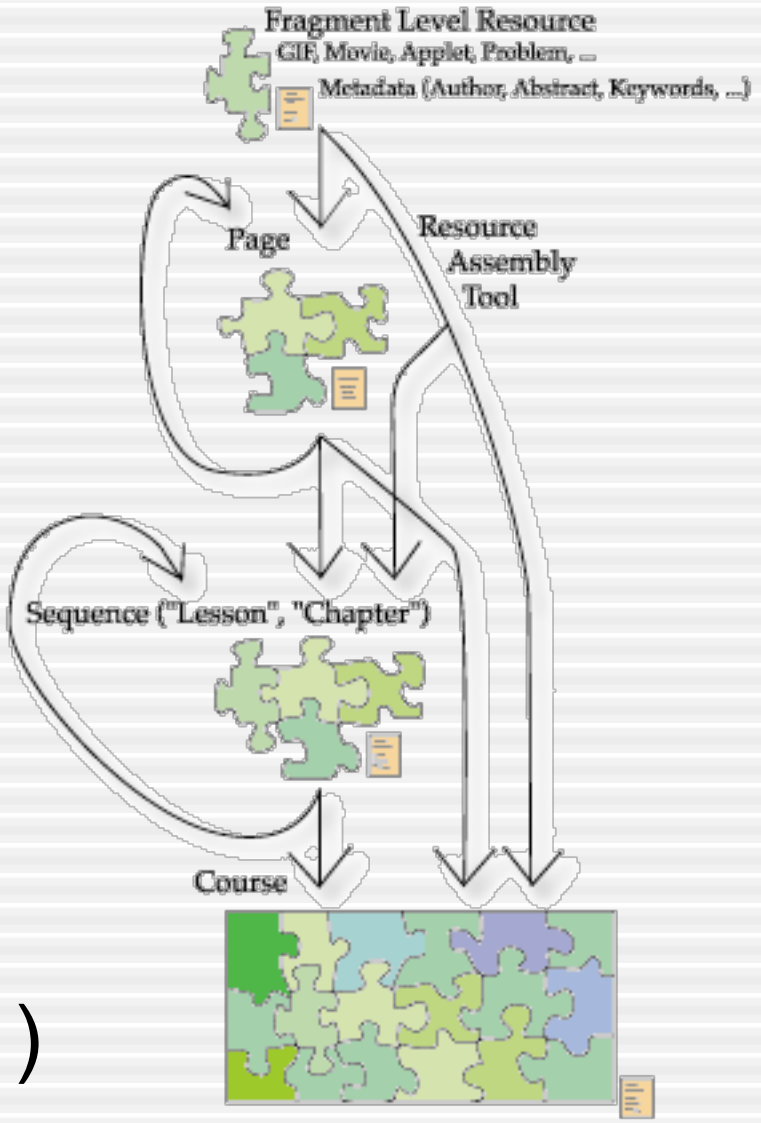
"Supermarket"



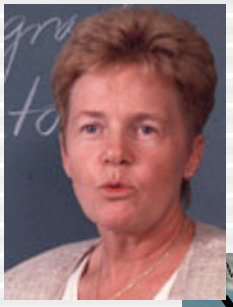
Resource Assembly

- 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

(Construindo o saber: um por todos e todos por um)

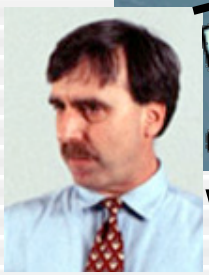


Resource Assembly



Writes module about energy conservation

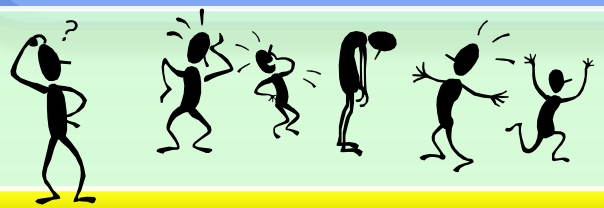
Compiles module about conservation laws



Writes module about momentum conservation

Uses whole assembly in his course

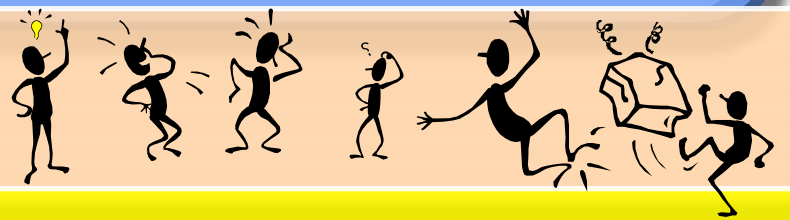
LON-CAPA Architecture



Course Management

Campus A

Resource Assembly



Course Management

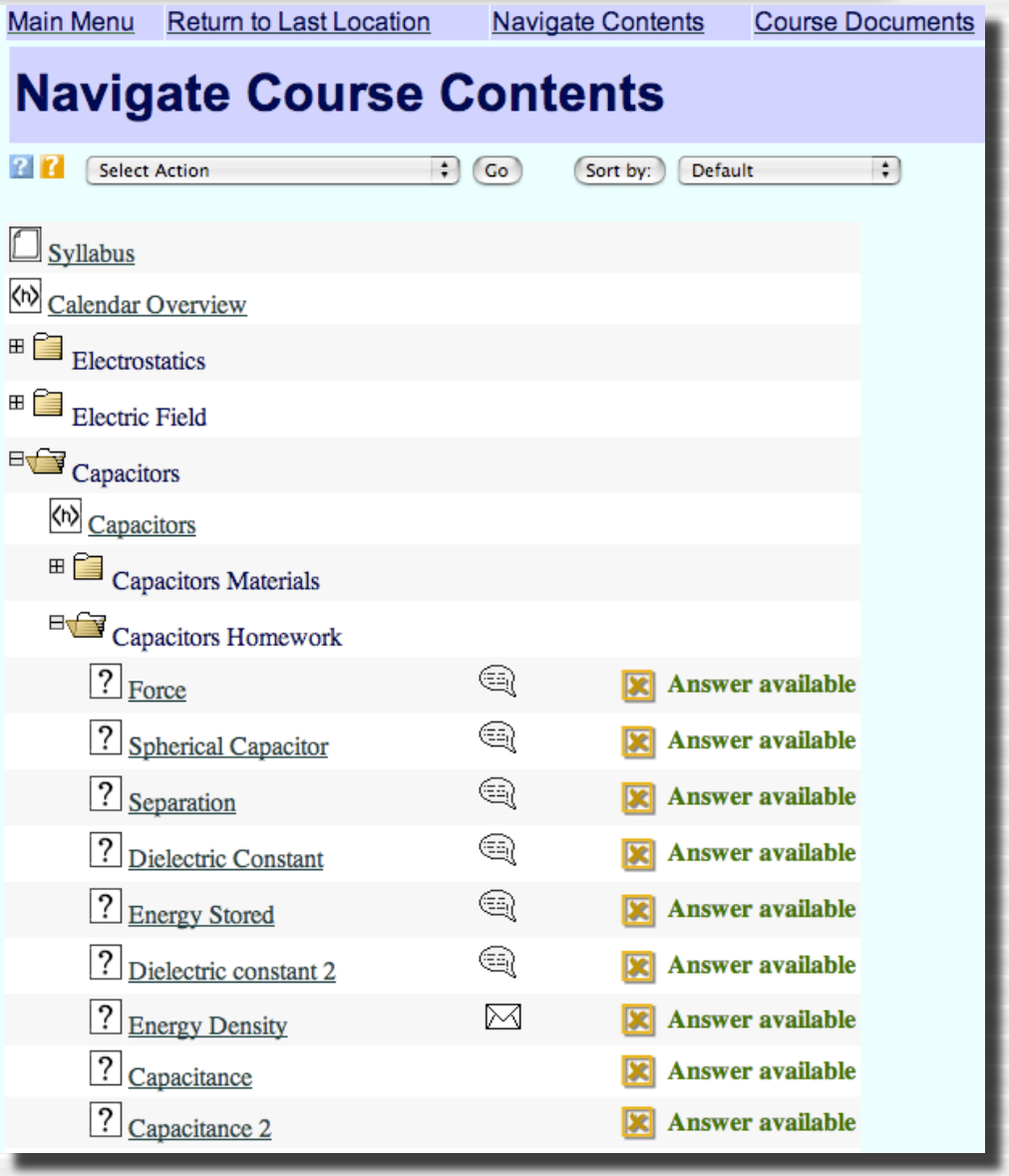
Campus B

Resource Assembly

Shared Cross-Institutional Resource Library

Course Management

- Instructors can directly use the assembled material in their courses
  - navigational tools for students to access the material
  - grade book
  - communications
  - calendar/scheduling
  - access rights management
  - portfolio space



Course Management

- Course overview/dashboard

Course Action Items

Gerd Kortemeyer
Course Coordinator
LBS 272 - Spring 2006

LBS 272 - Spring 2006 >Display Action Items — What's New?

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.

Hide all Show all

Problems requiring handgrading Hide

Problem Name	Number ungraded
Electric Field	4

Problems with errors Hide

No problems with errors

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

Change thresholds?

Resource	Part	Num. students	Av. Attempts	Deg. Diff	Last Reset	Reset Count?
Field Lines	single part	24	2.12	0.84		☐
Net Force	single part	53	2.49	0.80		☐
Pith Balls	single part	52	4.12	0.90		☐

Reset counters to 0

Resources in course with version changes since last week Hide

Change interval?

Resource	Last revised	New version	Version used
Applet: Electron Orbit	Fri Jan 13 10:18:52 2006 (EST)	10	10
Capacitance of a Sphere	Mon Jan 16 12:03:13 2006	8	8

Unread course discussion posts Hide

Change options?

Location	Type	Time of last post	Number of new posts
Coulomb	Resource	last Monday, Jan 16 at 04:55 pm (EST)	1
Distance Change	Resource	last Monday, Jan 16 at 07:00 pm (EST)	1
Field Lines	Resource	last Monday, Jan 16 at 07:49 pm (EST)	1
Force	Resource	on Wednesday, Jan 11 at 07:01 pm (EST)	3
Net Force	Resource	23 hours, 19 minutes ago	5
Pith Balls	Resource	last Monday, Jan 16 at 09:21 pm (EST)	6
Point P	Resource	last Friday, Jan 13 at 02:34 pm (EST)	5
Potential	Resource	last Sunday, Jan 15 at 03:15 pm (EST)	1
Two Charges	Resource	last Sunday, Jan 15 at 03:26 pm (EST)	1
Vector	Resource	last Saturday, Jan 14 at 01:32 am (EST)	1
Vectors	Resource	last Saturday, Jan 14 at 12:09 pm (EST)	2

New course messages Hide

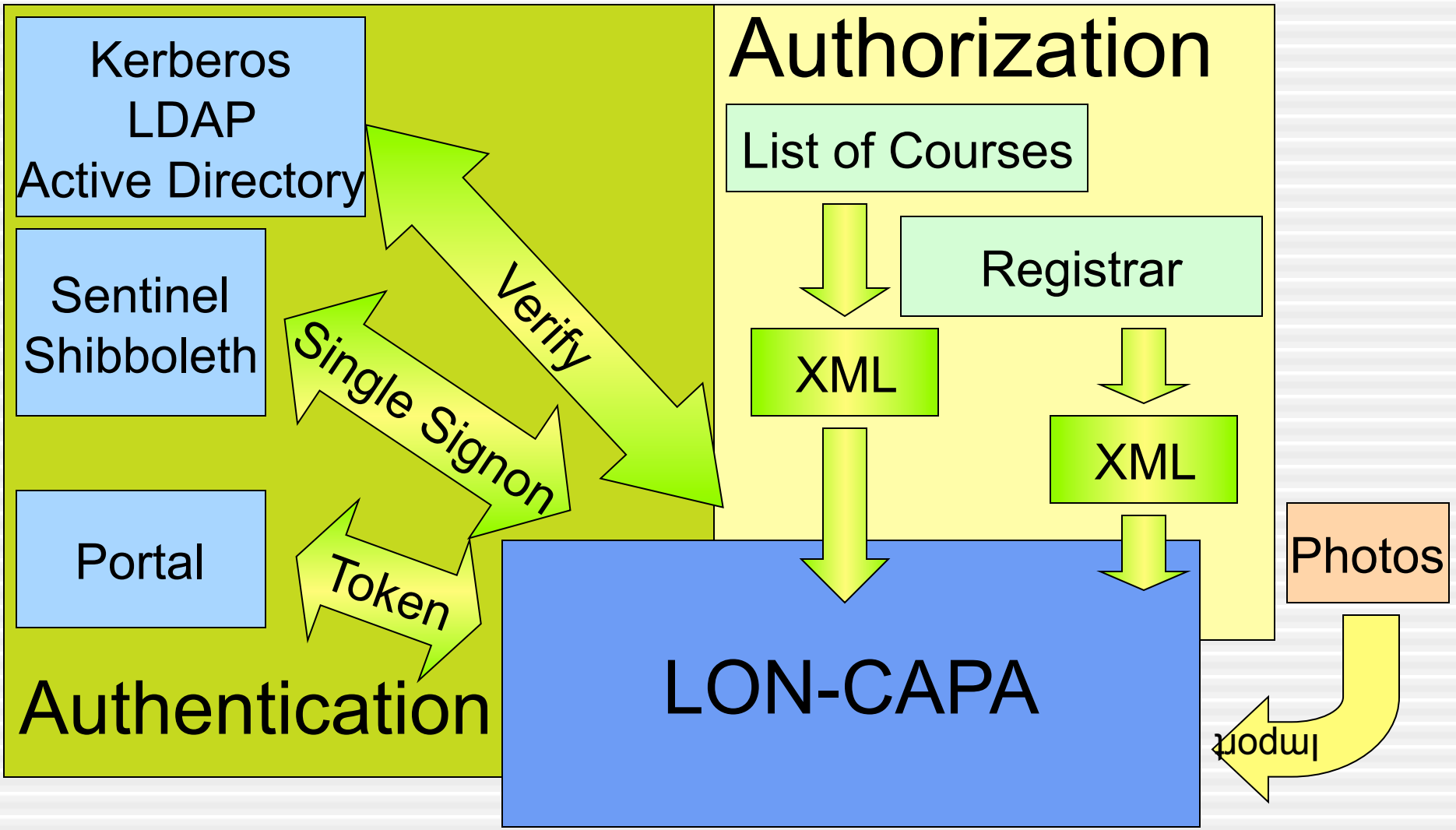
Number	Subject	Sender	Date/Time
1.	Feedback [msu/mmp/kap18/problems/cd460.problem]	[redacted]@msu	Sat Jan 14 10:45:02 2006 (EST)

New critical messages in course Hide

No unread critical messages in course

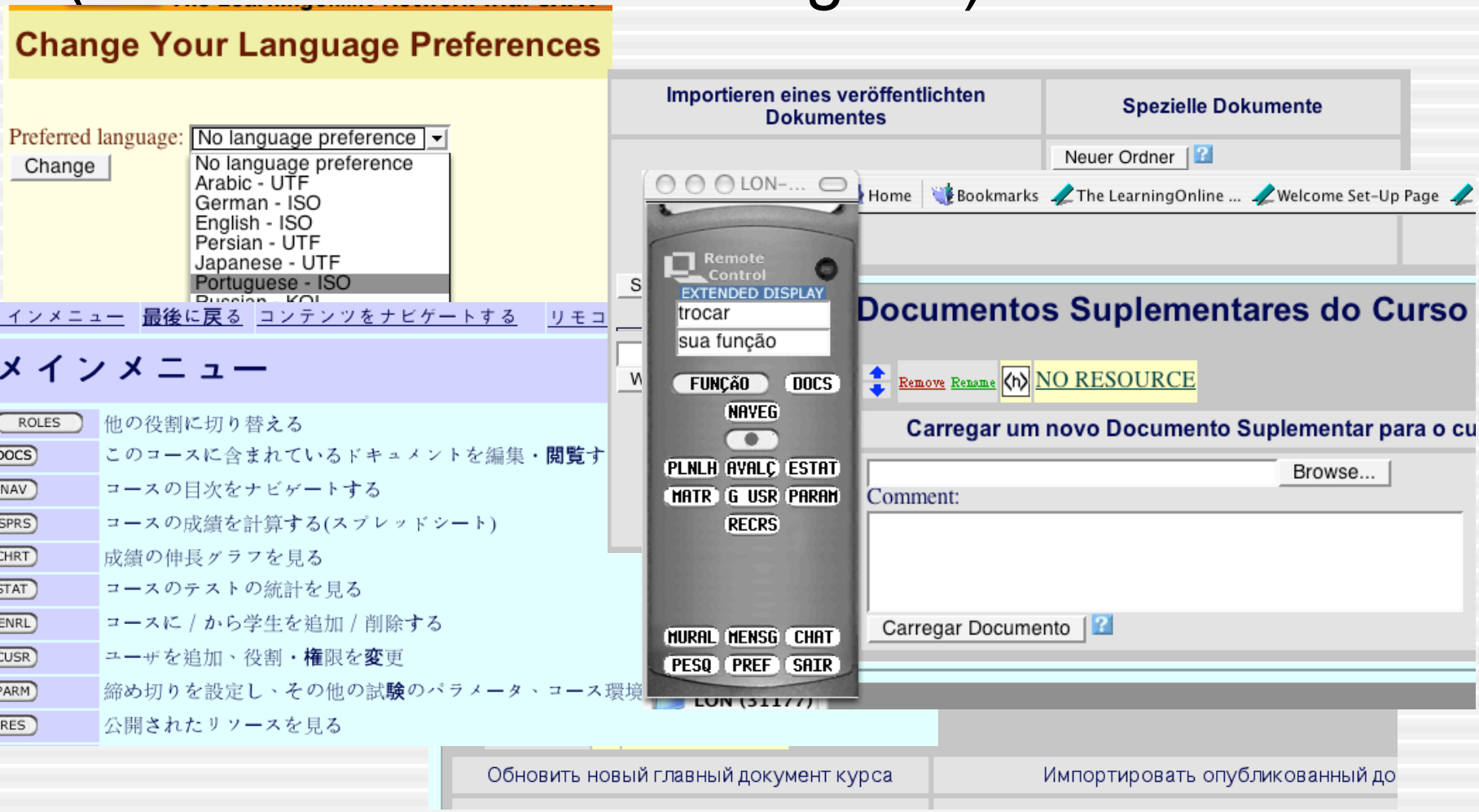
Course Management

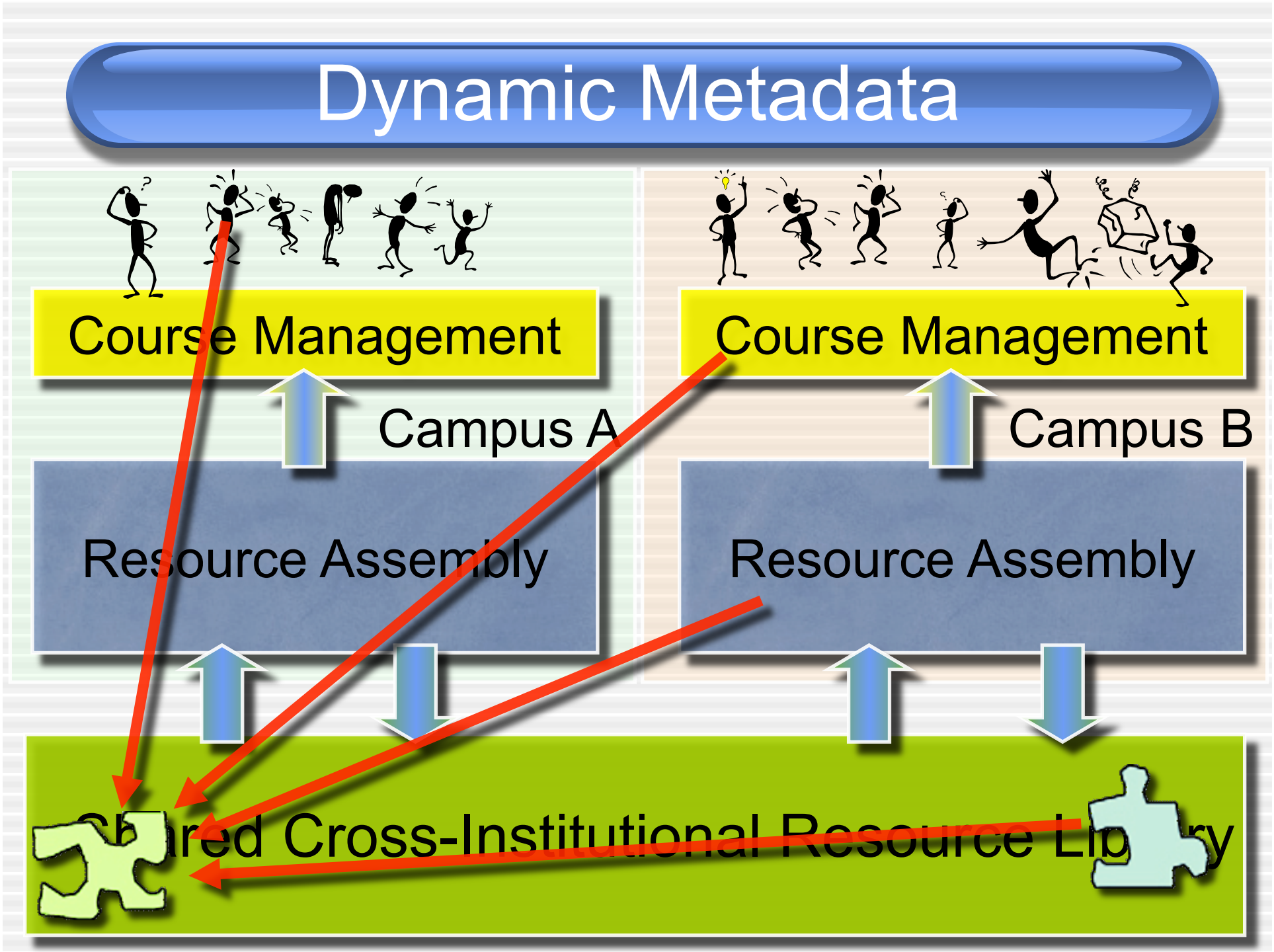
- Integrates well with central IT



Course Management

- Interface can be translated
  (LON-CAPA na sua Língua!)

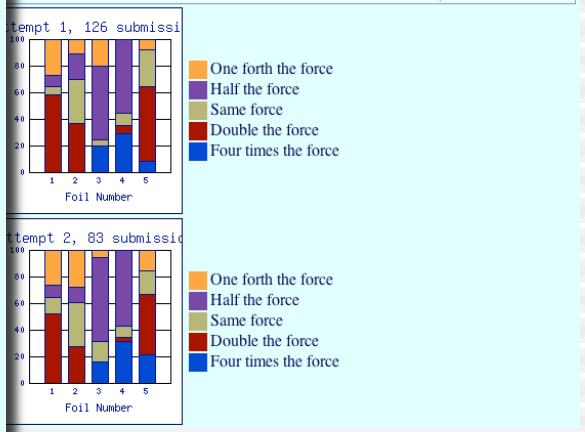



Dynamic Metadata
Course Management
Course Management
Campus A
Campus B
Resource Assembly
Resource Assembly
Shared Cross-Institutional Resource Library

Dynamic Metadata

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

Foil Number	Foil Name	Foil Text	Correct Value
1	1_6_1_1_2	The distance between the two charges is cut in half.	Four times the force
2	1_6_1_2_2	The magnitude of both charges is doubled.	Four times the force
3	1_6_1_3_2	The magnitude of one of the two charges is doubled.	Double the force
		stance between the charges is doubled.	One forth the force
		arges are placed in a medium with a factor two higher permittivity.	Half the force



Access and Usage Statistics

Network-wide number of accesses (hits)	890
Number of resources using or importing resource	1 • Eukaryotic Gene Control [msu/bio/Gene_Expr/111f03GeneCntrl.sequence]
Number of resources that lead up to this resource in maps	1 • Back to the Original Question [msu/bio/Gene_Expr/problems/originalquestion.problem]
Number of resources that follow this resource in maps	1 • Eukaryotic vs Prokaryotic Gene Expression II [msu/bio/Gene_Expr/problems/eukvsprokII.problem]
Network-wide number of courses using resource	3 • LBS 145 - Spring 2004 • ZOL 341 - Fall 2003 • BS 111 - Fall 2003

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)

Research

LON-CAPA como ferramenta e campo de pesquisa

Research

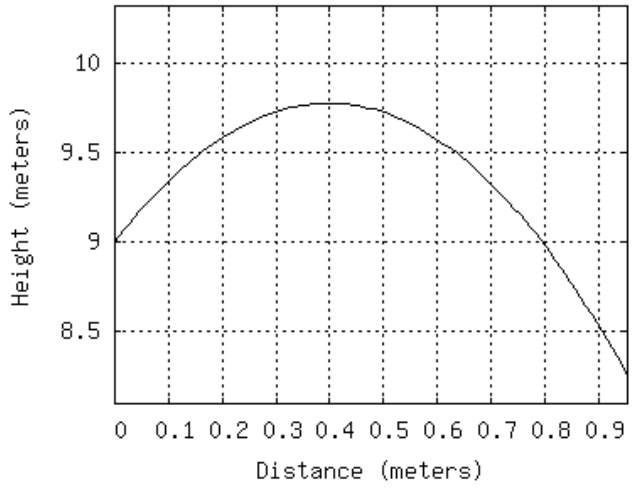
- Over the years, we did research on …
  - resource sharing
  - effectiveness of online homework
  - online student discussions
  - gender differences

Resource Sharing

- Online communities of practice
- Contributors versus users (institutions)

		U01	U04	PR01	U06	U17	U05	U03	HS20	U12	PR06	U11	U08	U
	Available	144418	17545	10809	8799	7635	7037	5120	4439	4066	3750	3283	2989	27
	Used	38245	7596	340	4821	2908	4880	3411	3842	2841	1502	1231	2102	3
	Used externally	17099	1804	339	974	276	3507	1735	1035	1997	1502	415	62	3
	Using													
U01	38855	34790	301	105	17	49	1621	294	74	102	298	137	3	
U05	11668	4881	23	14	3	33	4357	866	29	500	328	5	3	
U04	10343	2393	6969		10		207	374	8	128	2	18		
U06	10089	2261	64	13	4755		305	1001	8	10	2	72	2	2
U03	9973	4053	58	27	5	84	1213	3173	7	728	14	166		
U08	8578	2014	1078	6	2	2	720	5					2097	
HS20	6465	2138	1	47			40	350	3767	21	70	4		
CC04	6356	1156	25		2	31	1586	789	197	1522		64	7	
U17	6270	2689	4	7		2813	188	205	94	140	4		2	
HS40	5251	3899	22	5		40	65	293	388	70	27	16	1	
U14	5135	1682	213	42	12	1	665	42		3	7	114		
U09	4246	3409	7		1			15		1		1		
U12	3768	184					136	760		2684				
HS39	3467	2101	19	20	5	2	68	26	29	1	808	71		

Online Discussions



The plot shows the trajectory (height versus distance) of an object launched at an angle of 75.6 degrees. What was the initial speed of the object? **4.0 m/s**
Computer's answer now shown above. Tries 0/12

Threaded View Chronological View Sorting/Filtering options Export?

Anonymous 1 (Fri Sep 22 01:26:29 2006 (EDT))

any hints to start?

Re: *Anonymous 2* (Fri Sep 22 01:56:48 2006 (EDT))

You need to find the Y component of velocity... you can do this by finding the height traveled (notice it does not start on the ground) and combining that with acceleration in a kinematics equation. From there use trig to get the original velocity.

Re: Re: *Anonymous 1* (Fri Sep 22 12:10:37 2006 (EDT))

how can we find the height traveled and how can we get the acceleration if we don't have the time?

Anonymous 3 (Fri Sep 22 16:41:27 2006 (EDT))

i'm lost on this one... can anyone help?

Re: *Anonymous 4* (Fri Sep 22 20:02:45 2006 (EDT))

Use the squared kinematics equation - so Vf^2 = Vi^2 + 2a (Xf-Xi).

Discussions
Encouraged, since all students have different versions. Peer-Teaching. (Discussões online como estratégia de ensino)

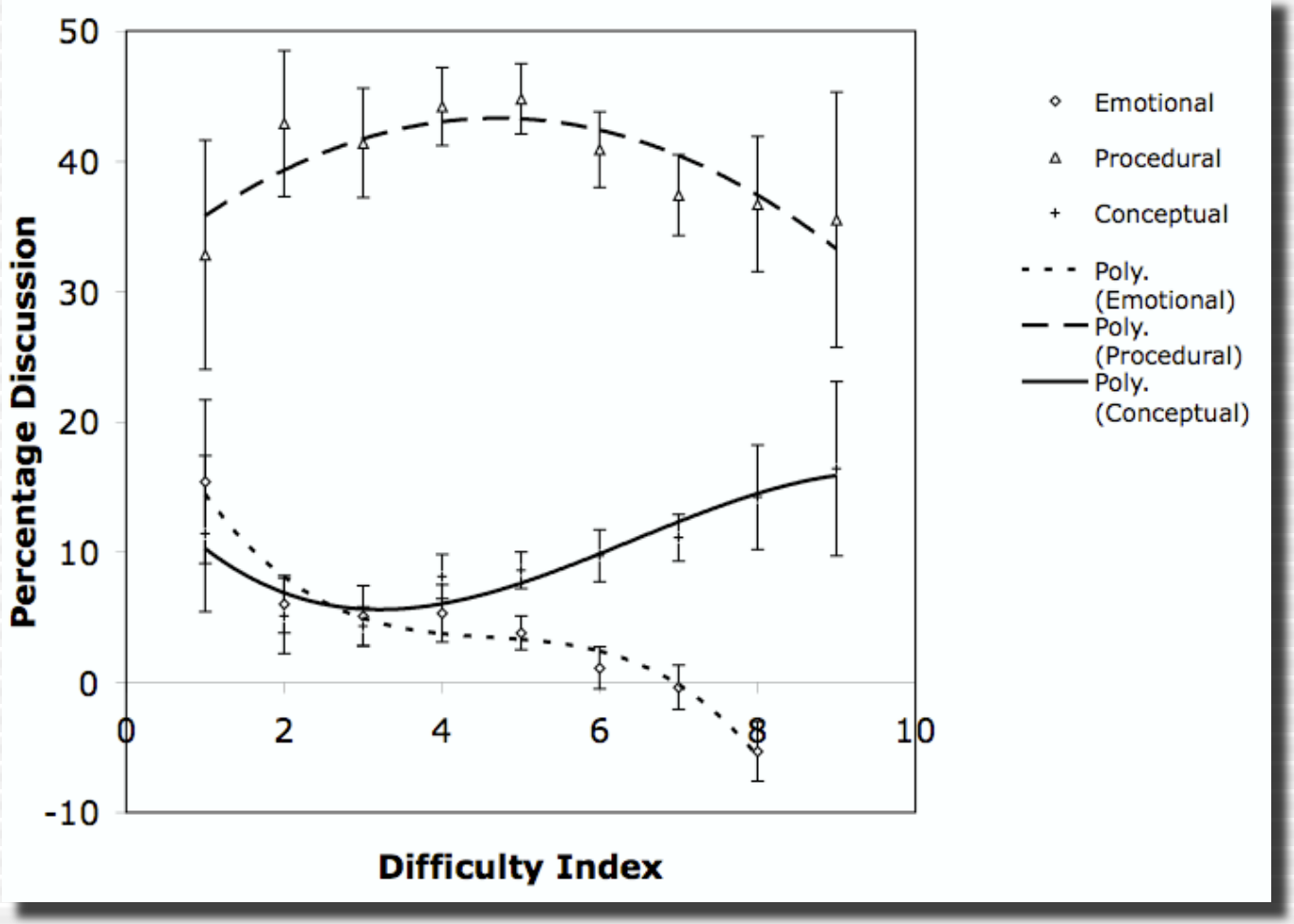
Classification

- Classification of discussion contributions

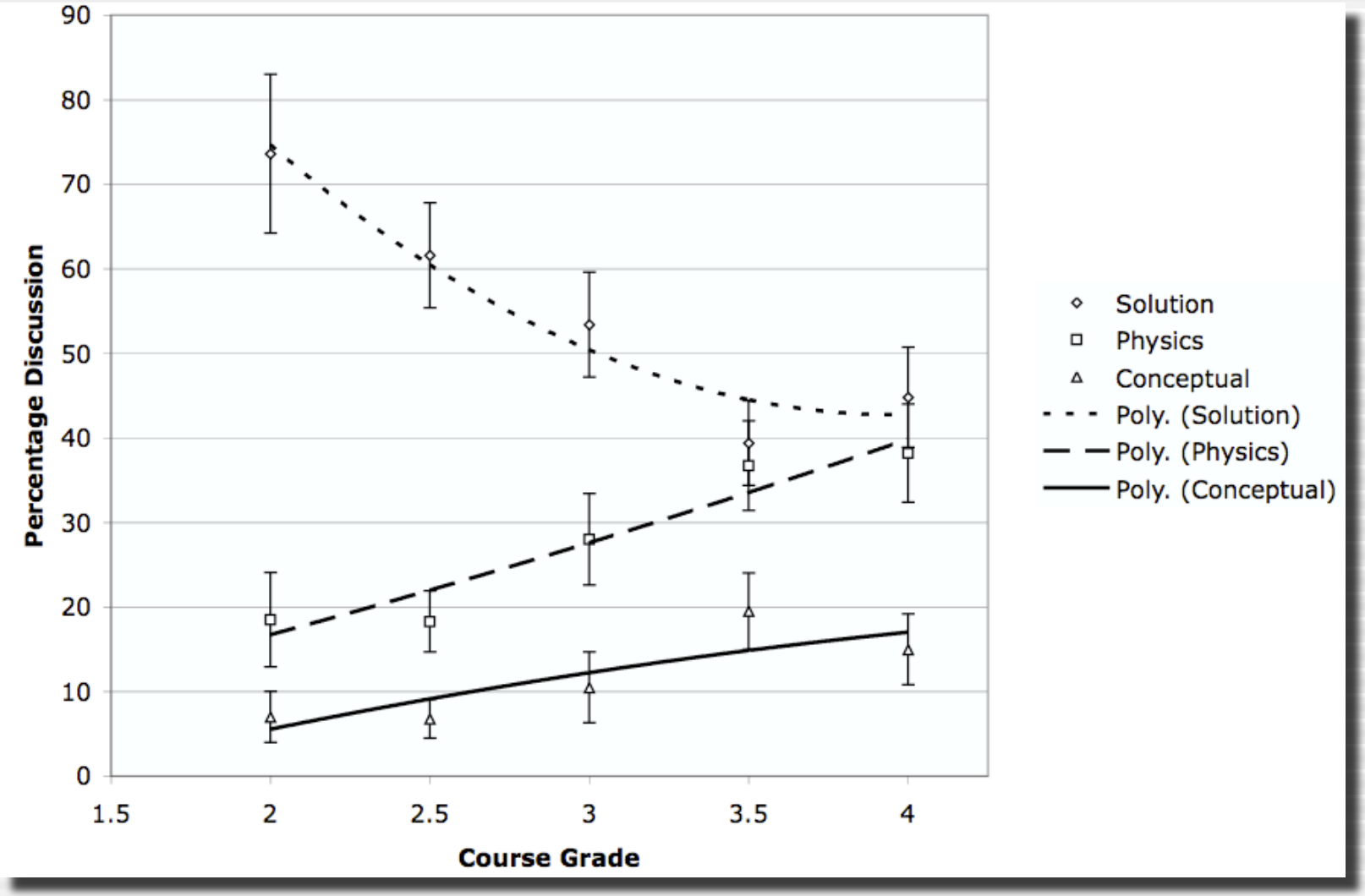
	Emotional		Surface		Procedural		Conceptual		
	Pos	Neg	Q	A	Q	A	Q	A	
Unrelated	71	54	10	1			1		137
Solution	279	185	601	341	353	456	12	3	2230
Math	1	6	49	36	73	87	3	6	261
Physics		14	85	81	170	190	100	126	766
	351	259	745	459	596	733	116	135	3394

Influence of Problem Difficulty

- More difficult than 0.6: “more pain, no gain”

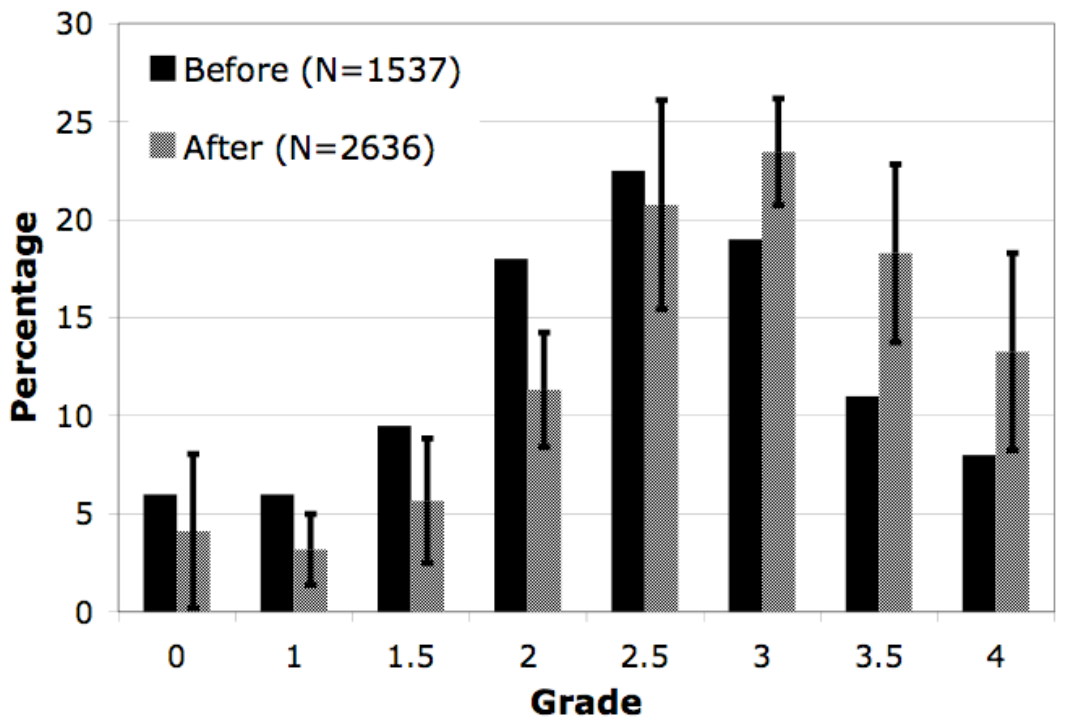


Do better students discuss better?



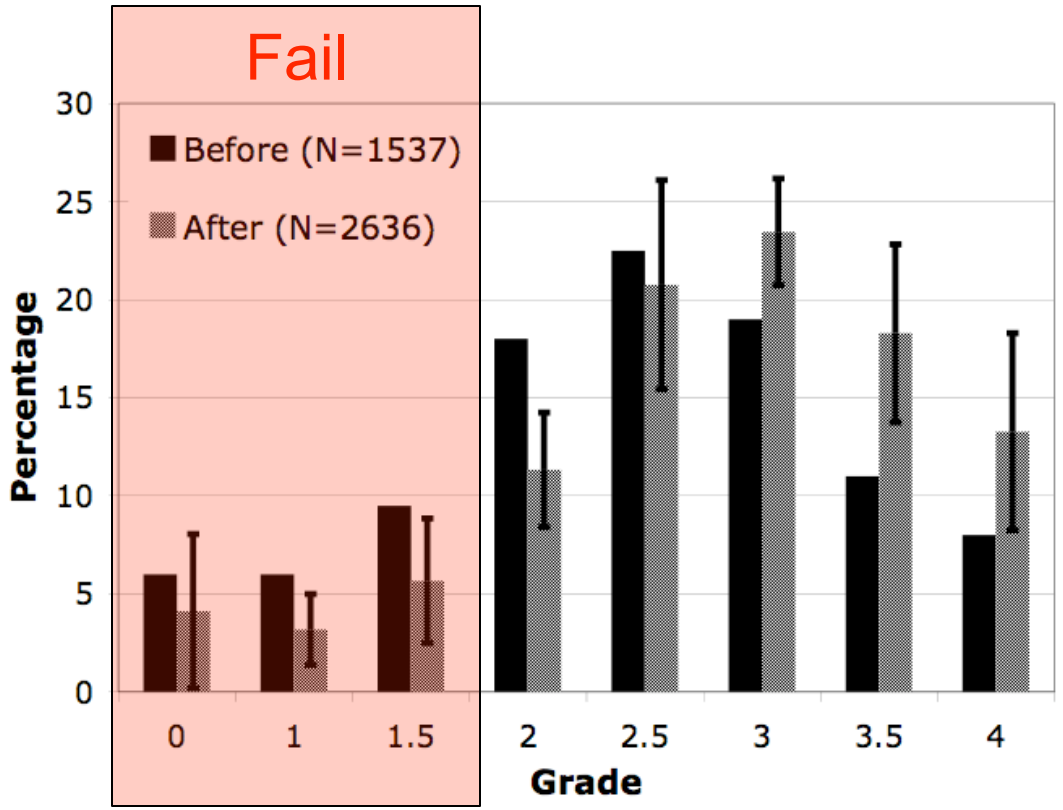
Learning Success

Same course, first semester with, second semester without online homework



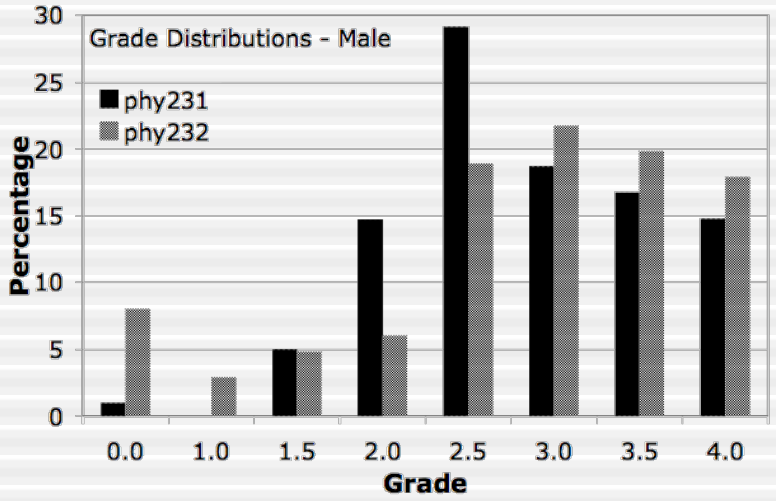
Learning Success

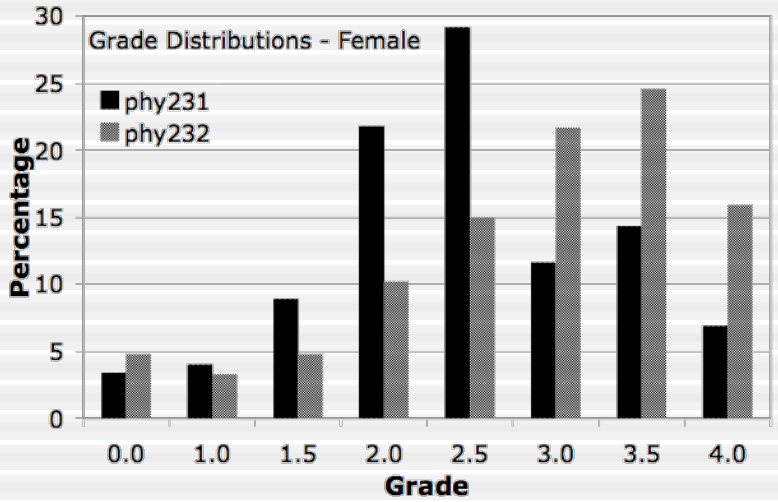
Mostly helps students who are on the brink of failing the course.



Gender Difference

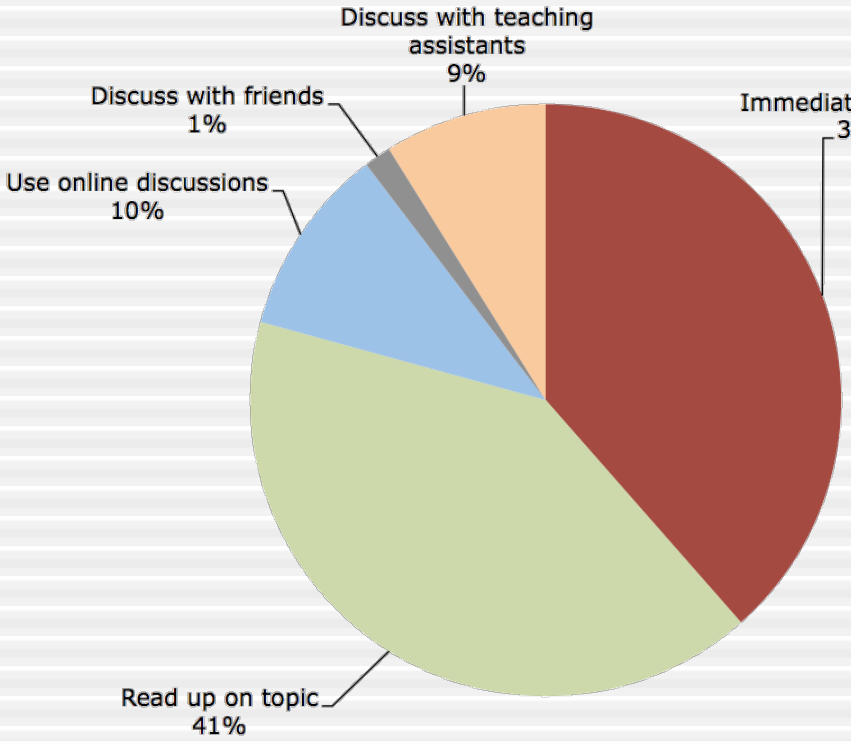
- phy231:
  without LON-CAPA
- phy232:
  with LON-CAPA
- Gender difference
- But why?



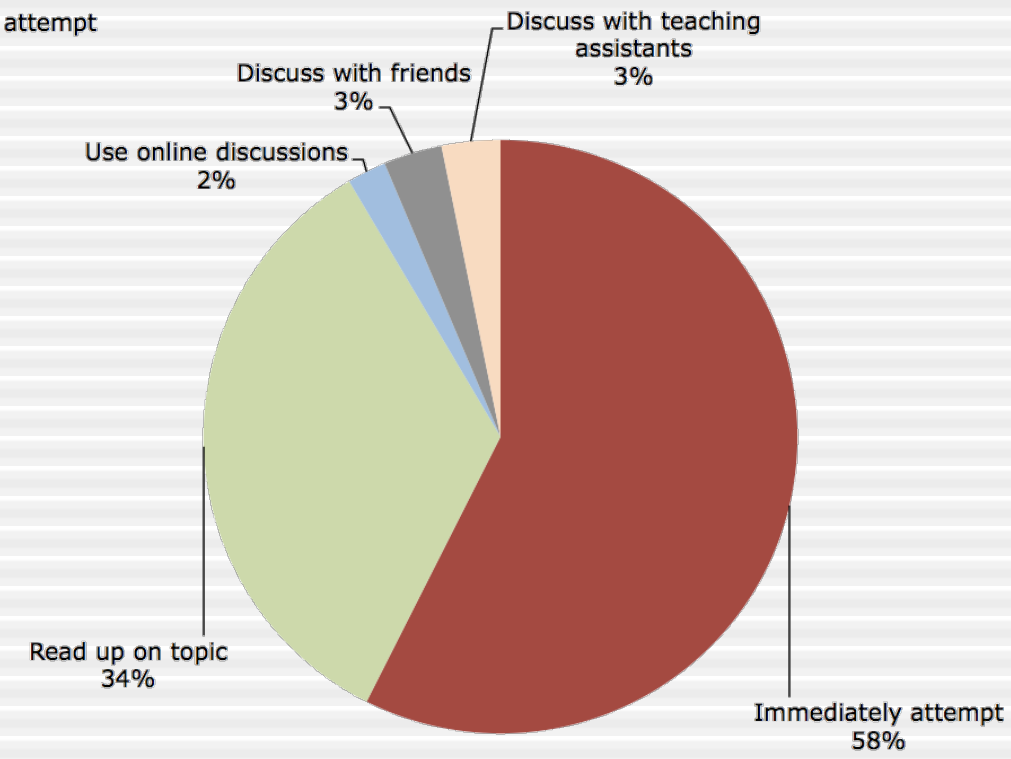


Gender Difference

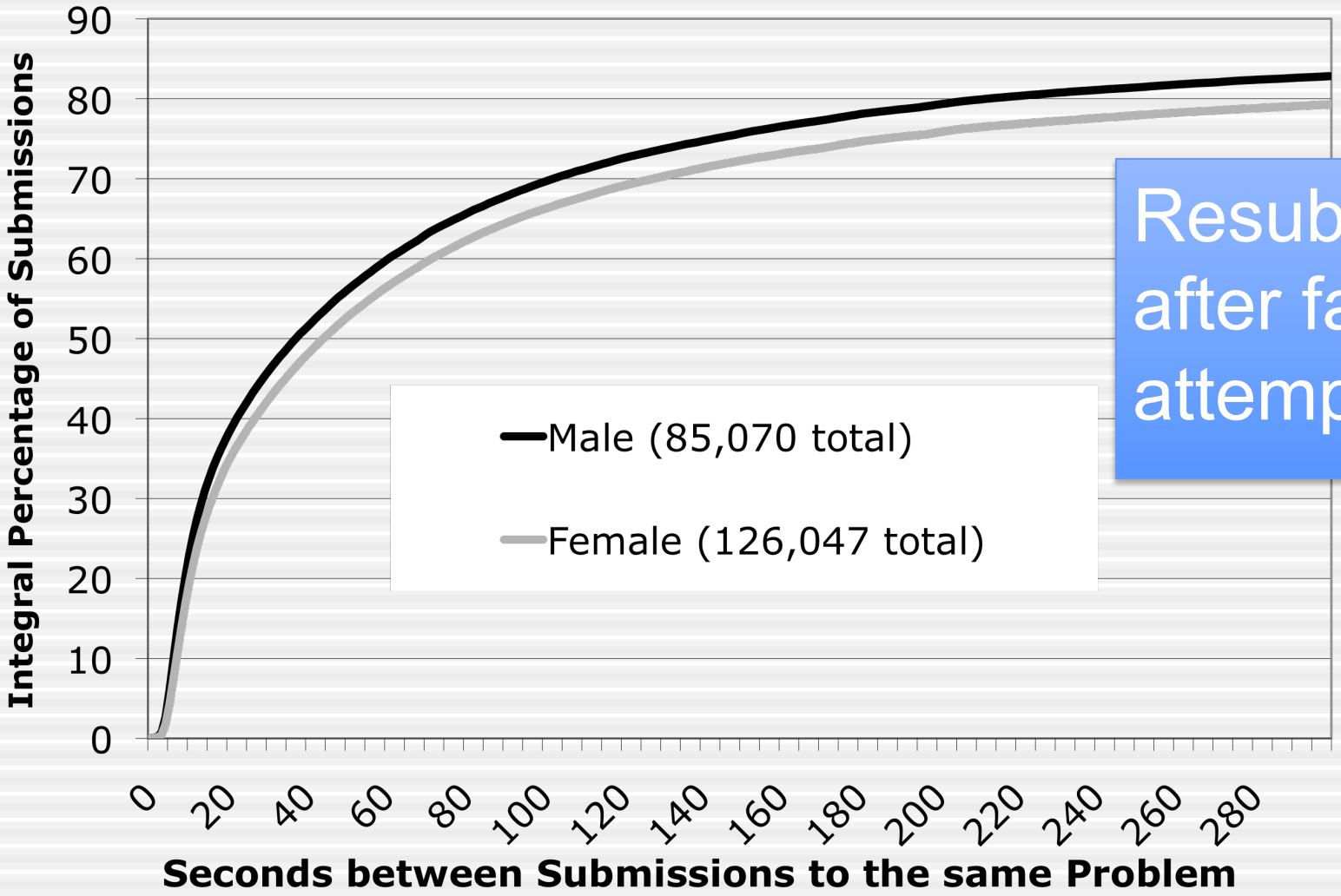
Initial Action on Homework: Female



Initial Action on Homework: Male



Gender Difference

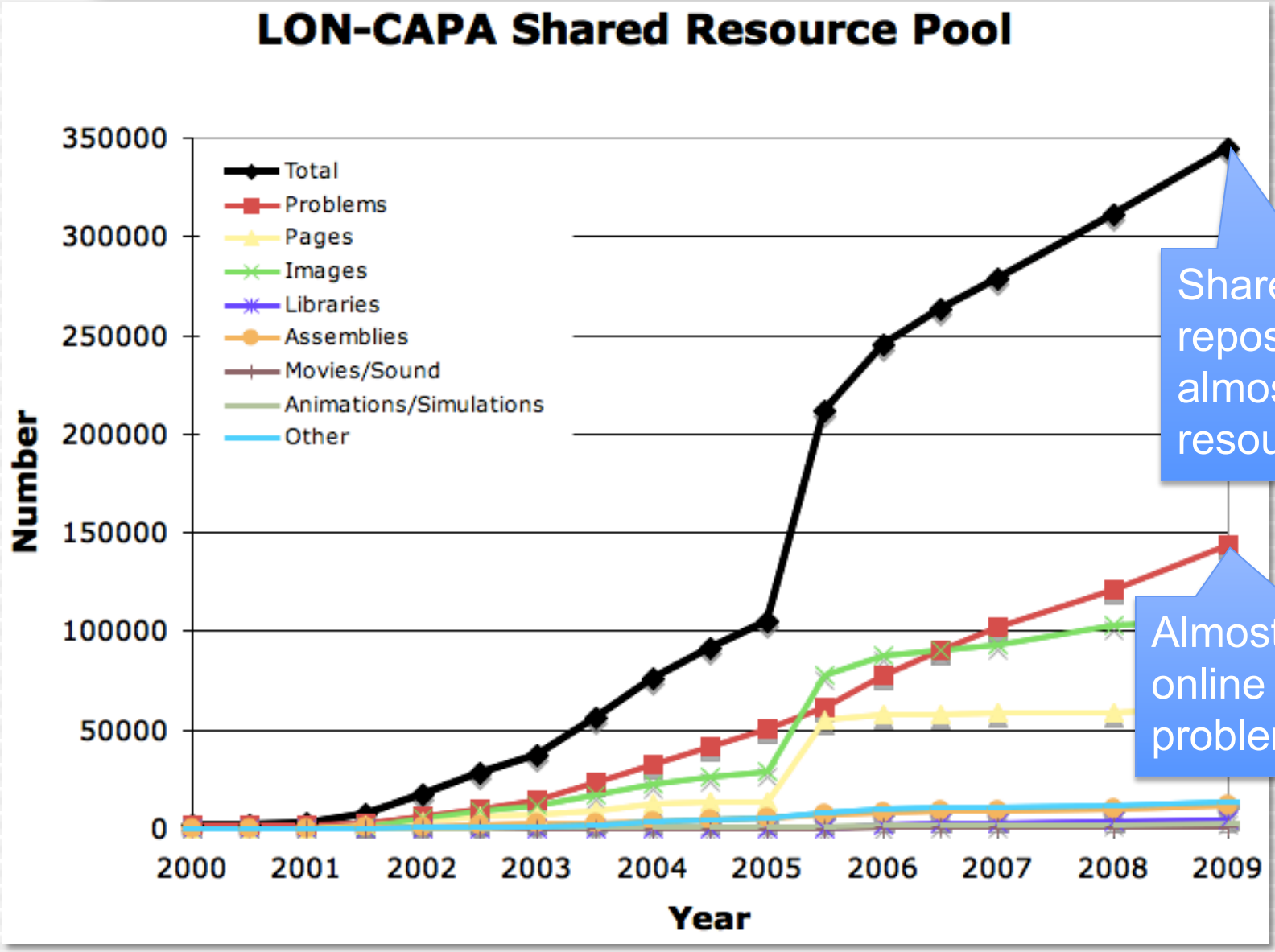


Resubmission after failed attempt

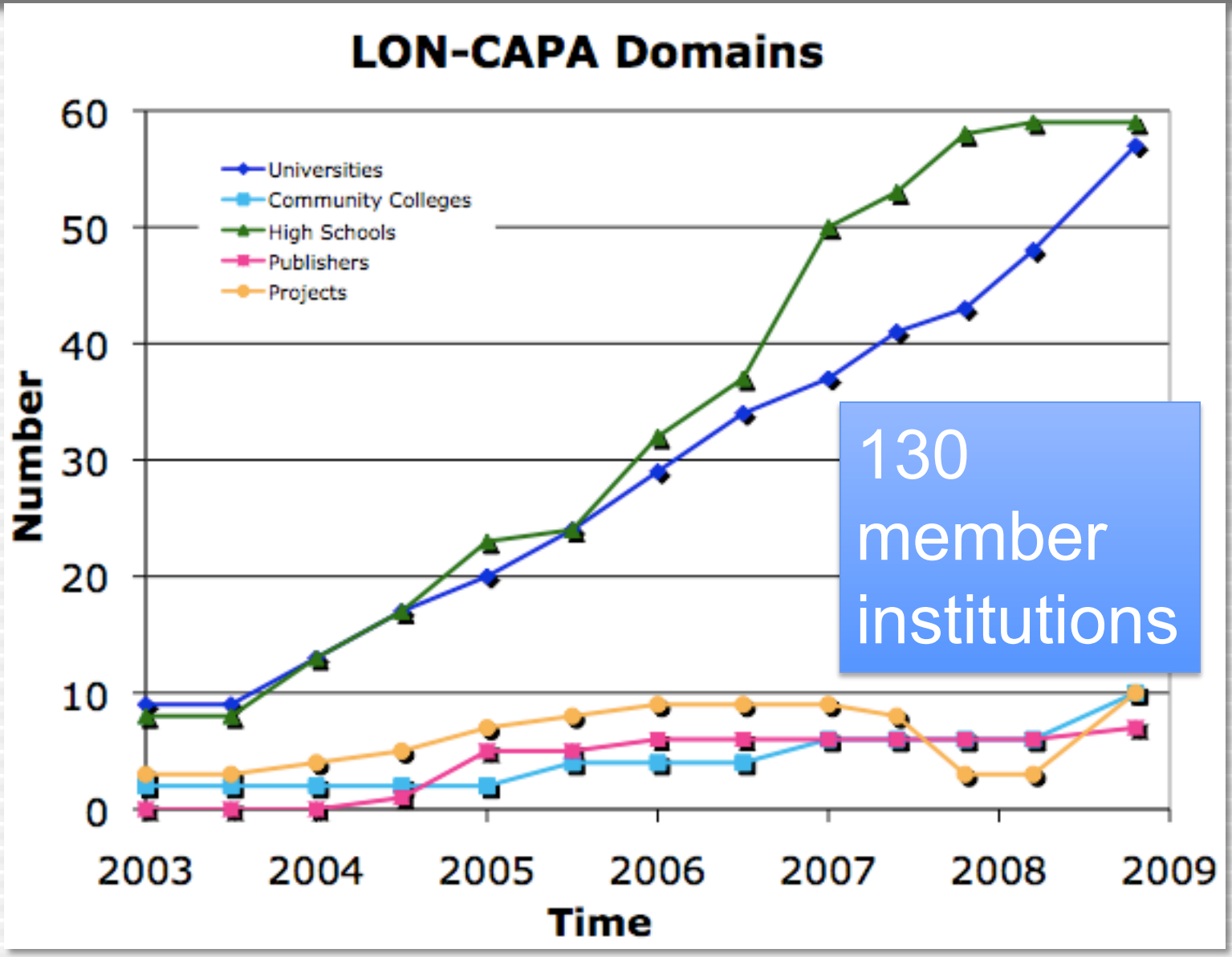
Community

O Universo LON-CAPA

The LON-CAPA Community

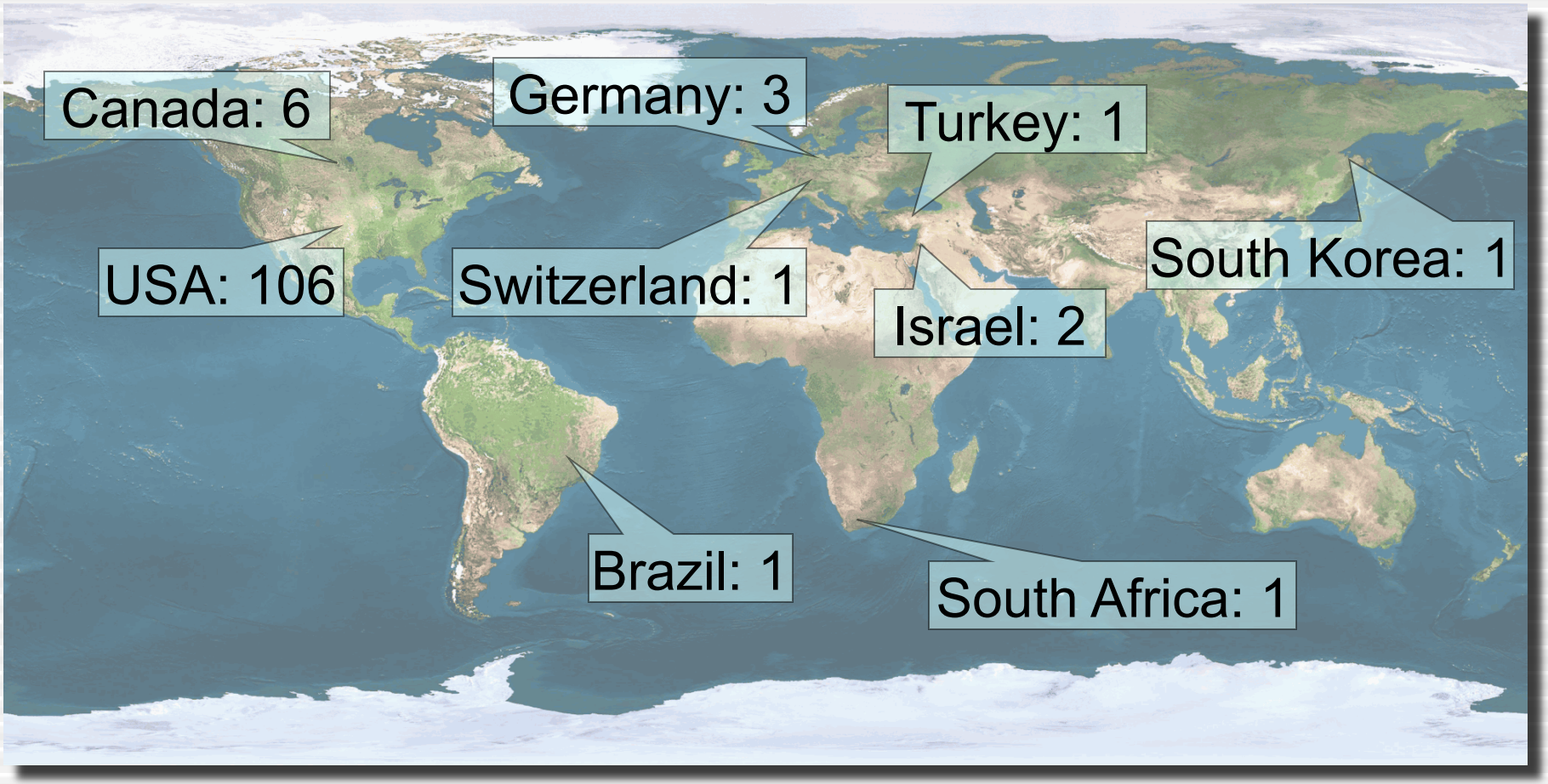


The LON-CAPA Community



The LON-CAPA Community

High Schools, Colleges, and Universities



… plus grant projects and publishing companies.

The Consortium

- Out of the 130 member institutions, five form the LON-CAPA Academic Consortium
  - Three institutions that made long-term financial commitments:
    - Simon Fraser University
    - University of Illinois at Urbana-Champaign
    - Michigan State University
  - Two institutions continually contributing to the code base and development:
    - Ohio University
    - University of Applied Science, Wolfenbüttel
- Governing board and long-term sustainability

Running LON-CAPA

- Running LON-CAPA
  - Locally
    - Dedicated Linux server or virtual machine
  - Hosted
    - http://www.educog.com/

LON-CAPA in Brazil

- LON-CAPA has been used with publisher content for physics courses at the Universidade de São Paulo
- During fall semester: research study at USP, comparing results obtained in the USA with results in Brazil.

Thank You!

- More information about LON-CAPA can be found at

http://www.lon-capa.org/

Muito Obrigado!