Web Based Physics:

Perpetuating the Past or Fomenting a Future?

Creating Lifelong eLearning Environments From the Convergence of Computing, Communication, and Cognition

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Abstract

- Computing, Communication, and Cognition (the famous three C's) have changed physics instruction in very significant ways. In spite of the leadership that physics has exhibited in each of these areas, most introductory physics instruction remains a dismal regimen of lecture, recitation, and lab. Meanwhile the number of physics majors has fallen to the lowest number in a half century. Coincidence?
- (http://www.aps.org/units/fed/spring2002/wilson.html)
- Distance education courses in many cases have been described as "lecture halls with the back wall pushed out x thousand miles." As Physics instruction goes online, will it merely automate the old models or will it truly incorporate the lessons of the three C's. Models of better formats exist and have been fairly widely (although hardly universally) applied in physics instruction. High quality or low quality models, that is the question.

Other interests

*e*Learning

- Formerly
  - Provost (interim)
  - Dean of Faculty
  - Dean of Undergraduate Ed.
  - Dean of Professional Ed.
  - Director, Center for Innovation in Undergraduate Ed.
  - Chair, Physics Department
  - Professor for 30 years +
- Chairman & Founder of LearnLinc Corporation.
  - Mentergy => (NASDAQ: MNTE)

What shapes my views?

*e*Learning

- Experience at Rensselaer implementing
  - Studio Classrooms/Interactive Learning/mobile computing
  - Interactive distance learning program
- National Acad. of Science/National Research Council
  - Committee on Information Tech.
  - Physics Decadal Overview Committee
  - National SMET Digital Library Committee +++
- Pew Center for Academic Transformation ($8.8 M)
- National Learning Infrastructure Initiative
- Chair: NYS Regents Task Force on Distance Learning
- Industry Consultant (IBM, AT&T, Lucent, Ford, GM...)
- Wash. DC: 8 years working on HS. and Univ. Sci. Ed.
- Lots of visits, speeches, writing, reading, and visitors

UMassOnline

*e*Learning

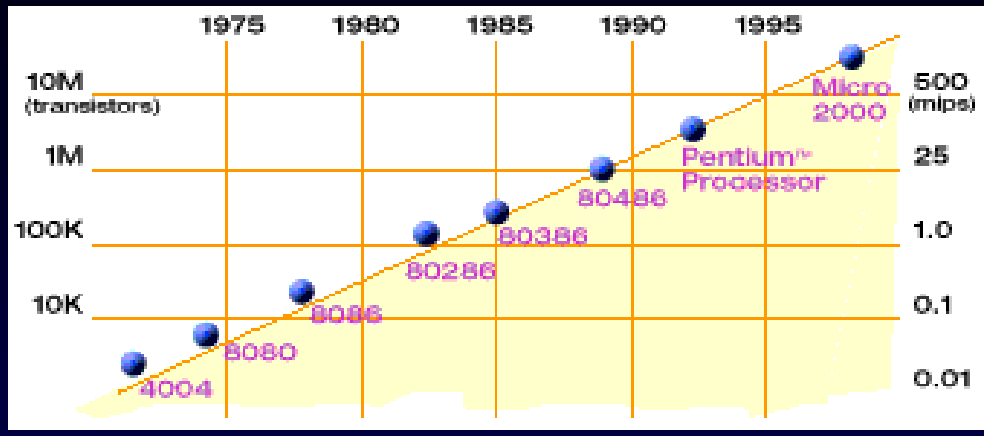
- Virtual University for Massachusetts
- 6800 Enrollments
- Graduate, Undergraduate, Cont.Ed.
  - MBA, M.Ed., MPH, MS in Nursing, HRTA, EE, CS
  - BS in Liberal Arts, CS, Nursing, etc. etc.
  - Many kinds of certificates

The Three C's

- Computing
- Communication
- Cognition

Computing and Communication

*e*Learning



- Moore's Law:
  CPU performance
  doubles every 18 months

- Bandwidth law:
  Bandwidth is doubling even faster!

- Metcalf's Law:
  the value of a network scales as n^2 where n is the number of persons connected.

The horrible mismatch

- Technology changes very rapidly
- People change very slowly

Cognition

- Among the sciences, technology, engineering, and mathematics (STEM) disciplines, Physics has led the way on the application of the cognitive sciences to the practice of physics education.
  - Arons, McDermott, Redish, Laws, Thornton, Hake, Mazur, Zollman, Fuller, Hestenes, etc. etc. etc.
- Some have focused on the fundamental research while others have created new courses based upon that research.

Denial

- With all this leadership: why is it that introductory physics instruction remains a dismal regimen of lecture, recitation, and lab?

- Meanwhile the number of physics majors has fallen to the lowest number in a half century.

  – Coincidence?

The decline of the physics major

*e*Learning

- In 1999, (the last year for which complete data has been made available by AIP) the absolute number of physics majors reached the lowest point since the end of the 1950's.
- If this is not shocking enough, then it could be compared to the nearly four-fold increase in the total number of bachelor's degrees over this period.
- the trend line for primarily undergraduate institutions has remained relatively level over the last four decades while the undergraduate degrees granted by doctoral and master's degree institutions has declined to approximately **half the value of 1970**.

Undergraduates Too Often Shortchanged

- Nevertheless, the research universities have too often failed, and continue to fail, their undergraduate populations. Tuition income from undergraduates is one of the major sources of university income, helping to support research programs and graduate education, but the students paying the tuition get, in all too many cases, less than their moneys worth.

  – The Carnegie Foundation

Research Universities Cheating Undergrads?

- "Untrained teaching assistants groping their way…tenured drones who deliver set lectures from yellowed notes," anybody we know?
- A report released by the Carnegie Foundation for the Advancement of Teaching bluntly accused the nation's research universities of false advertising.
  - What's New @ APS by Robert L. Park

Lewis Perelman

- “I've analyzed and forecasted trends that, I am increasingly confident, will lead eventually to the collapse of the academic system in a way and for reasons that are basically the same as those that led to the collapse of the Soviet system.”
- Perelman does not think that there is any hope at all for reform in higher education and he thinks that reform is a complete waste of time.
- In his words: “I have no interest in reform; and, when asked, I discourage others from wasting time and money on it. Education reform over a period of decades has proven to be either unnecessary, futile, irrelevant, or even downright harmful. ”

Denial

- Others in higher education are in denial. They hide behind platitudes of "**immutable values**" and "**centuries of stability**."
- A well known physics educator once asserted to me that the lecture and current structure of higher education was the "stable product of long evolution."
  - evolution does not create "stable products!"
- It will be important to understand the core values and practices and to see how they play out in this changed environment.

APS: Challenges in Physics Ed. (98) *e*Learning

- "Departments generally justify their existence to university officials on two grounds:
  - 1) the excellence of their graduate programs and their ability to attract large amounts of outside research funding and
  - 2) the large number of student credit hours produced by the introductory level service courses in physics."
  - The relative weighting of the two criteria depends critically on the kind of institution with the Carnegie Research 1 and 2 and Doctoral 1 and 2 (the Doctoral-Granting Institutions in the former Carnegie Scheme) focusing on item one to a greater extent while the Comprehensive universities and colleges, the liberal arts Colleges and the two year (or associate granting) colleges putting the greater emphasis on the second.

What are the healthier opportunities?

- Key Trends:
  - Pervasive Technology
  - Globalization
  - Mass Customization
  - Focus and Differentiation
- In Universities, remember the 18-21 year old will still be with us, and many will want the whole thing.
  - Focus on the Student's Experience
- Learning is a life long process and cannot require students to **always** go back to campus.
- Give students choices: face-to-face/online/blended/etc.

Pervasive Technology

*e*Learning

- Studio Classrooms
- Laptop Curriculum
- Fully wired campus
- Fully “wireless” campus
- Online courses

- Used pervasively not just for homework, in computer labs, or outside of class.

Many Models of Web Based Physics?

- The Web enhanced course
  - Using the web to distribute syllabi, lecture notes, etc.
  - A spectrum ranging from the mundane add-on to pretty sophisticated designs.
- The Sloan ALN “anytime anyplace” model.
  - Fully online, web materials, chat, threaded discussion, homework, assessment, etc.
  - Difficult to use with less motivated students in “must pass” courses (core required courses)
- The “Blended model”
  - Often anyplace but not fully anytime
  - Live on-line learning, video feeds, face to face.

Coping with change

- Design for the future not the present
- Design based upon human learning and not technical limitations
- When forced to compromise by technology
  - Remember it is a compromise
  - Do not enshrine compromises
  - Watch how technology changes can eliminate need to compromise.

Whither Web based Physics?

- Distance education courses in many cases have been described as "lecture halls with the back wall pushed out x thousand miles."
- As Physics instruction goes online,
  - will it merely automate the old models or
  - will it truly incorporate the lessons of the three C's.
- Models of better formats exist and have been fairly widely (although hardly universally) applied in physics instruction.
- High quality or low quality models, that is the question.

Components from which to select

*e*Learning

- Live-online mini lectures & discussions (VOIP)
- Live polling
- Java applets for interactive simulations
- Microcomputer based data acquisition
- Web based multimedia
- Online texts
- Customized homework.
- Threaded ALN discussion
- Live Chat
- Virtual laboratories and team based case studies
- On-line surveys and tests.

Globalization

- Extending your reach globally
  - Not just marketing your programs overseas
- Bringing global experiences to students
  - Junior year abroad is nice …. but…..
  - An international student body is nice…… but…
  - Exchange programs are nice ……but….
- Allowing students to participate in experiences that they could not have in their schools.

NTU-Rensselaer Course

*e*Learning

- Satellite broadcast
- Hands On Exercises
- Synchronous Tutoring
- Asynchronous support

NTU-Rensselaer Course

*e*Learning

- “Hands On World Wide Web”
- Feb. 10 & 17, 1998
- 8000 participants
- 500 sites
- Most successful NTU course ever
- “The future of satellite based education.”
  - Lionel Baldwin, President, NTU
- Certainly the largest!

- Survival Skills for Astrophysics
- Professor Chun Ming Leung
  - Graduate Students in Astrophysics
    - Video/Audio/ LearnLinc Web Data Conf.
    - Both ISDN and Internet connection
    - 7 am Eastern (6 Hong Kong)
    - Student Collaborative Presentations
    - One Semester length

Mass Customization

- *The notion is that you take ~~customers~~ **students** and put them at the center of their own universe. –Jeff Bezos, CEO of Amazon.com*
  - Amazon.com
  - Dell Computer
  - Expedia.com

Mass Customization

*e*Learning

- Mass Customization is **NOT**
  - Pandering
  - Allowing the student to define the course
  - Abdicating responsibility for student learning
- Mass Customization **IS**
  - Based upon sound cognitive research
  - finding out where the student is (initial condition)
  - Defining a personalized path to success
- Mass customization is only practical through creative use of technology

Focus and Differentiate

- No more “all things to all people”
- Not every institution can sell distant learning to Asia!
- Watch for “consolidation” or “shakeout”
  - Failures are good for the system and bad for the victim
- What is YOUR special expertise?
  - Babson, CalTech, etc.

From Research to Education

*e*Learning

- Distributed Learning and Web based Physics Instruction can bring cutting edge physics directly to the learner.

- And the learner may not be an 18-25 year old residential student!

Chemical Mechanical Planarization

*e*Learning

- RPI/Intel/Applied Mat./ Matsushita/IBM
  - New York; Osaka, Japan; California; Arizona; Texas
- Murarka, Schowalter, Duquette
  - (Introduction to Copper Metalization)
  - (Wall Street Journal article)
- Month long course to engineers and scientists in the workplace.
- Video/Audio/LearnLinc Web data Conf.
  - ISDN and Internet
  - ProShare, PictureTel, Panasonic multipoint

You ain't seen nothin' yet

- How can technology help?
  - Remember Moore's Law, the Bandwidth Law, Metcalf's Law.
  - Present asynchronous courses are primitive and rudimentary precursors to real distributed learning.
  - Don't wait, get started now.

- "Don't look back, somethin' might be gaining on you." –Satchell Paige

U.S. Problem

- Few high school students studying math & physics
- Lack of qualified teachers
- Rural and inner cities are particularly bad
- Solution:
  - LearnLinc used to teach physics over the network
  - Funded by:
    - AT&T
    - Lucent
    - Bell Atlantic
    - IBM

Remote Physics Course

*e*Learning

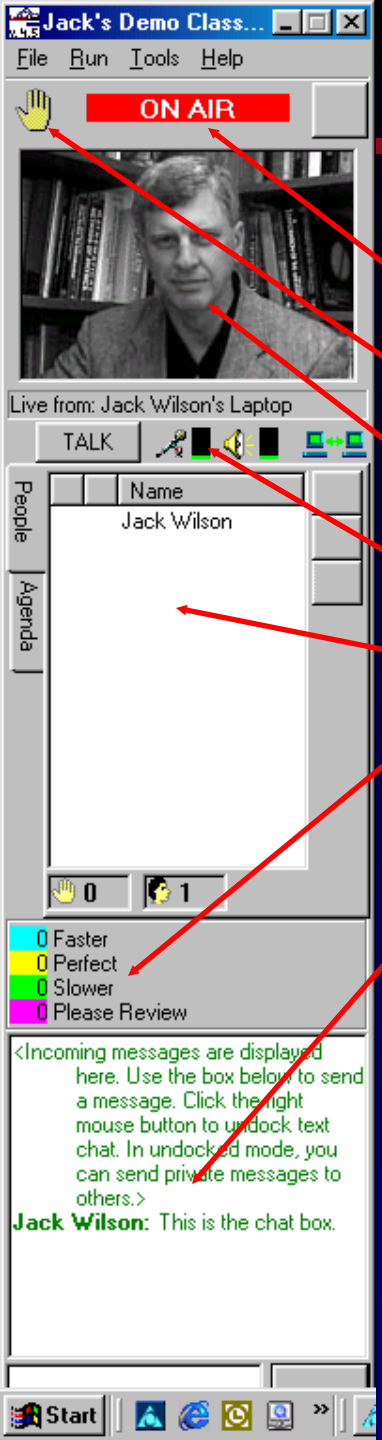
- Introductory Calculus Based Physics
- Delivered via ILINC LearnLinc
- Cobleskill High School in rural upstate NY
- Collaborative between the physics teacher at Cobleskill and faculty and graduate students at Rensselaer

Introduction to eBusiness

*e*Learning

- eExecutives eLearning eBusiness
- Fall 2000: Tuesday night from 6:30-8:30 pm
  - 125 Students: 50 On and 75 Off Campus
    - IBM, Ford, GE, Intel, Sun, Lockheed Martin, Pratt and Whitney, Ford, Consolidated Edison, NY Power, J. P. Morgan, Carrier, Otis, etc.
  - Extensive Website:
    - http://www.jackmwilson.com/eBusiness/Syllabus-Spring2001/
  - MBA, MSIT, MSES
  - miniLectures, Discussion, Student presented cases, & asynchronous interactions
- Spring 2001 –overflow- 70 total: (25 on and 45 off)

eLearning



- On- Air indicator
- Raise your hand
- Picture or video of speaker
- Audio and Network controls
- Agenda or class roll
- Feedback section
  - (can be pace, agreement, T/F, Yes/No, etc.)
- Chat Window

LearnLinc Client

File Run Tools Help

Nichole

Live from: San Francisco, CA

Mute

People | Agenda

Name

Isaiah Beres
Owen Carter
Tom Elliot
Wally Emerson
Ben Frank
Geoff Gamache
Alicia Hoffman

2 25

0 Not much progress
5 Still working
7 Almost finished
13 Completed

Nate: Yes. Could you please review the chapter on formating graphs in Excel?

Raise your hand when you see the AppShare window.

Send

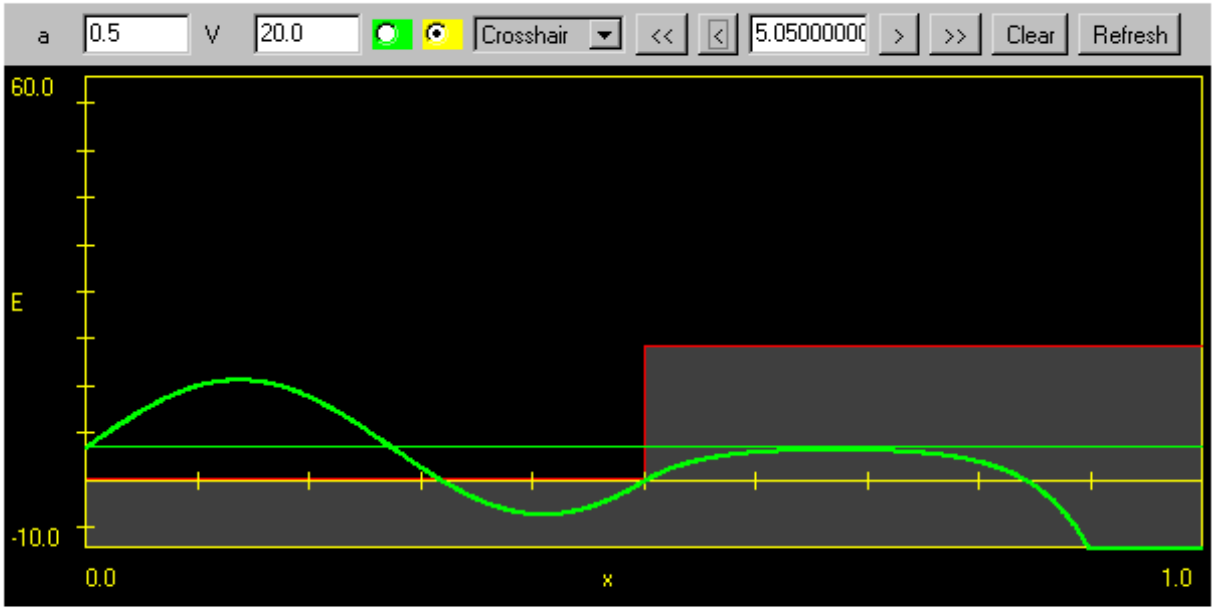
SquareWell - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss

Address D:\JavaPrograms\cde\SquareWell.html Go Links

This illustrates the solution of a quantum well with an infinite wall at x =0 and a finite potential of 20 V at x = 0.5 nm. - Jack Wilson



Author: Jack Wilson

Using the buttons to each side of the Energy window, you can adjust the energy of the particle in the well to see if the energy leads to a bound state. In a bound state the wavefunction will satisfy the boundry condition at infinity (on the right). It must go to zero to do that. You should find several bound states of the particle for the energy selected here.

Notice that you can select various annotation possibilities, including "Crosshair," "Derivative," "Integral," and "Chalk." You can use each one in combinations with the mouse and mouse button

Top Ten Ways to Fail

*e*Learning

1. **Broadcast the best lecturers** to thousands of people. The lecture is a wonderful time tested technology! It's easy and fun! Paul Samuelson can teach everyone economics! Lectures worked for us!
2. Build the coolest **multimedia interactive websites** (or CD-ROMS) with the production values of Star Wars.
3. Build **multimedia lecture theaters** which can be used to send the experience worldwide.
4. Design an Asynchronous Learning Environment so that all interactions are defined as between student and instructor. Keep that **instructor at the center**!

Top Ten Ways to Fail

*e*Learning

5. Assume that **Anytime/Anywhere education** is the holy grail of distributed education. Anyone can learn anything on asynchronous learning networks.
6. **Cost is not an issue** here. We are only interested in quality.
7. **Make a necessity into a virtue**. For example, since bandwidth does not allow good video, then video must be unneeded. Instant messaging and chat will do just fine!
8. Once you have adopted a platform, **stick with it** in spite of all the changes that keep going forward in internet time.

Top Ten Ways to Fail

*e*Learning

9. **Be very doctrinaire** about the learning models. There is only one right way to do this for everyone and every field.
10. **Ignore the work of others** who have gone before. You can do it better!

Ten Commandments of TEL

*e*Learning

1. **Restructure around the learner**. Neither over-emphasize nor under-emphasize technology.
2. **Build upon research results**, which inform design; don't try to reinvent the wheel.
3. **Remember that technology has an intrinsic educational value beyond helping students learn better**.
4. **Do systematic redesign and not incremental add-ons**. Do not automate the lecture. There is always a tendency to just add on a few computer experiences to everything else. By definition this costs more, is more work for faculty, and adds to the students' burden. An innovative approach changes rather than adding poorly integrated exercises.
5. **Benchmark your plans** and build upon examples of systematic redesign. Find the best examples and build upon them.

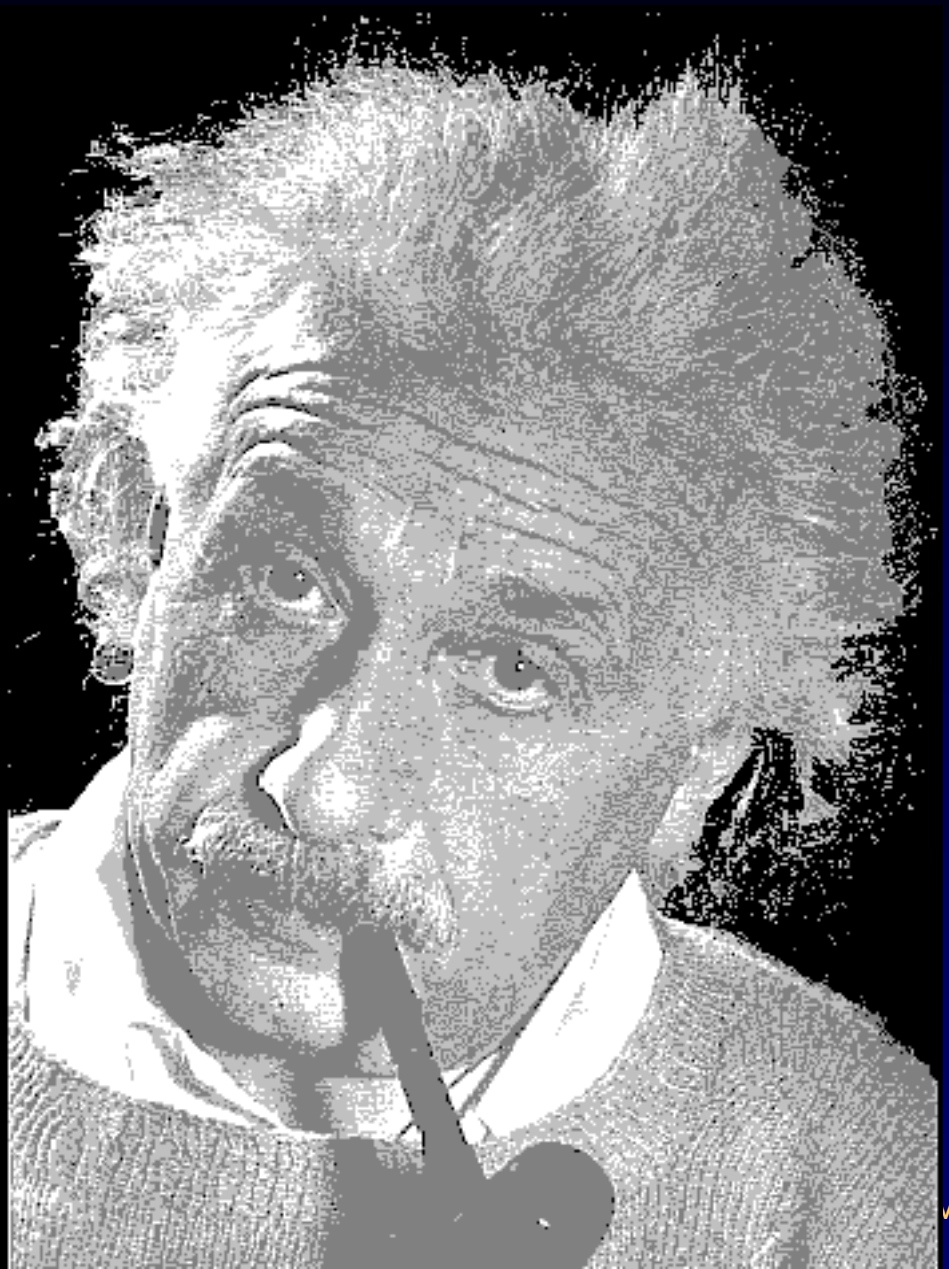
Ten Commandments of TEL

*e*Learning

6. **Count on Moore's law** ("What is hard today is easy tomorrow"). Eg., CPU power and bandwidth relentlessly double.
7. **Cost is an important aspect of quality**. There is no lasting quality if there has been no attention to cost. There are more than enough examples of expensive high quality solutions. We need more examples of inexpensive high quality solutions!
8. **Avoid pilots that linger**. Design for a large scale and pilot projects only as a prelude to scaling up. It is easy to design innovative educational experiences that work for small groups. It is harder to address the needs of the 1000 students taking calculus I at the large research or comprehensive university.
9. Develop a **balance between synchronous and asynchronous** distributed learning.
10. **There is no longer any way to do good scholarship without technology, and there is no longer any way to teach good scholarship without technology.**

What happens to me?

*e*Learning

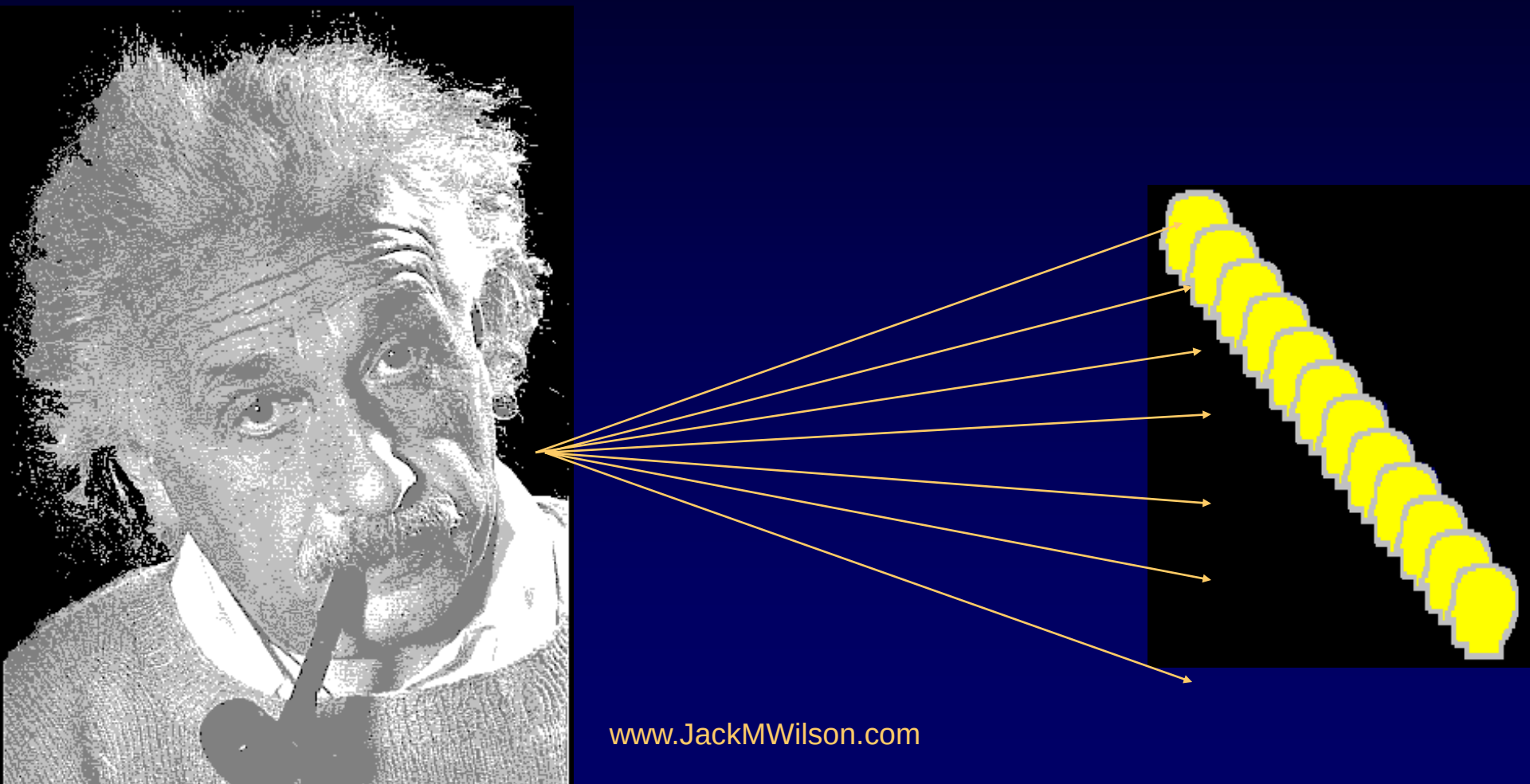


- Will the Web or a CD-ROM Replace your <Blank> Instructor?

The transmission model

*e*Learning

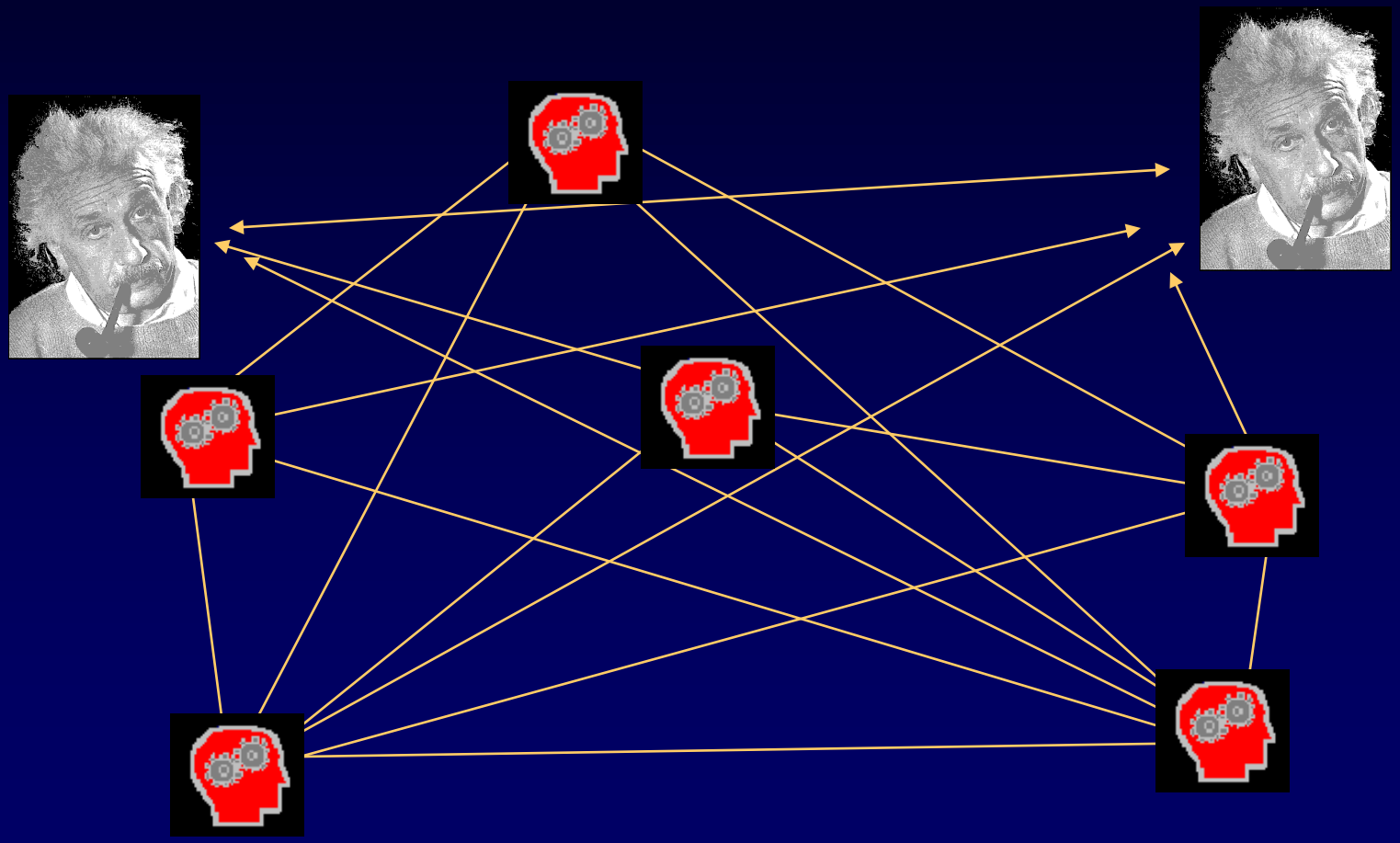
- The mainframe approach



Interactive Learning

*e*Learning

- Distributed Collaborative Model



The Studio Classroom

*e*Learning

- Hesburgh Award 1995
- Boeing Award 1995
- Pew Prize 1997
- Pew: $8.8 Million in 1999.

The Forty Year Degree

*e*Learning

- Christopher Galvin, President Motorola:

- We are not hiring any more graduates with four year degrees.
- We want employees with forty year degrees

Distributed Cognition

- The "Client-Server" model.
- Connecting students, instructors, and resources into a rich interacting community of learners.
- Peer Teaching
- Cooperative Learning
- Student-student as well as student-instructor and student-resource interactions
- Synchronous as well as asynchronous
- Video/Audio/ and Multimedia interactions
- The real "World Wide Web"

Distance Learning Technologies

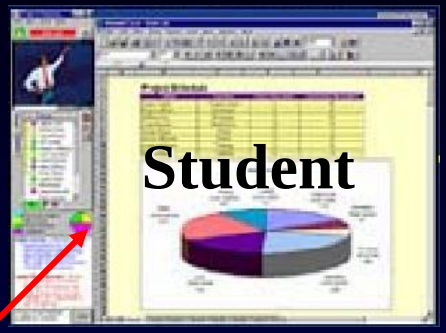
*e*Learning

- Satellite Video ($500,000)
- ISDN Videoconferencing ($50,000)
- PC Collaborative ($5,000)
- Web Based Asynchronous ($5,000)
- Materials
  - CD-ROM Creation
  - Mail out materials
  - World Wide Web materials
- Example: ILINC LearnLinc
  - Live Internet Audio (optional Desktop Video -multicast)
  - Network based materials management
  - Classroom management

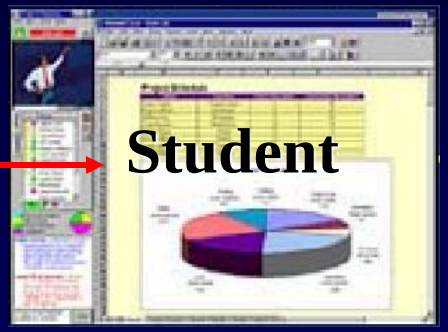
Mentergy LearnLinc

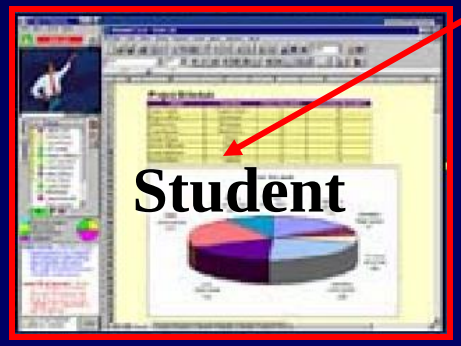
*e*Learning

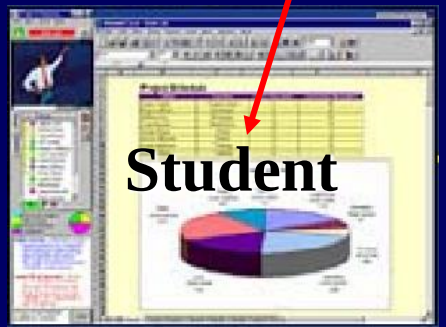
Instructor

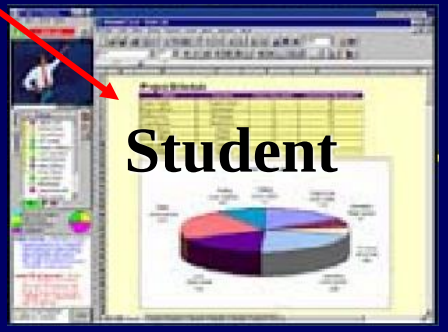


The Internet
Voice & Data



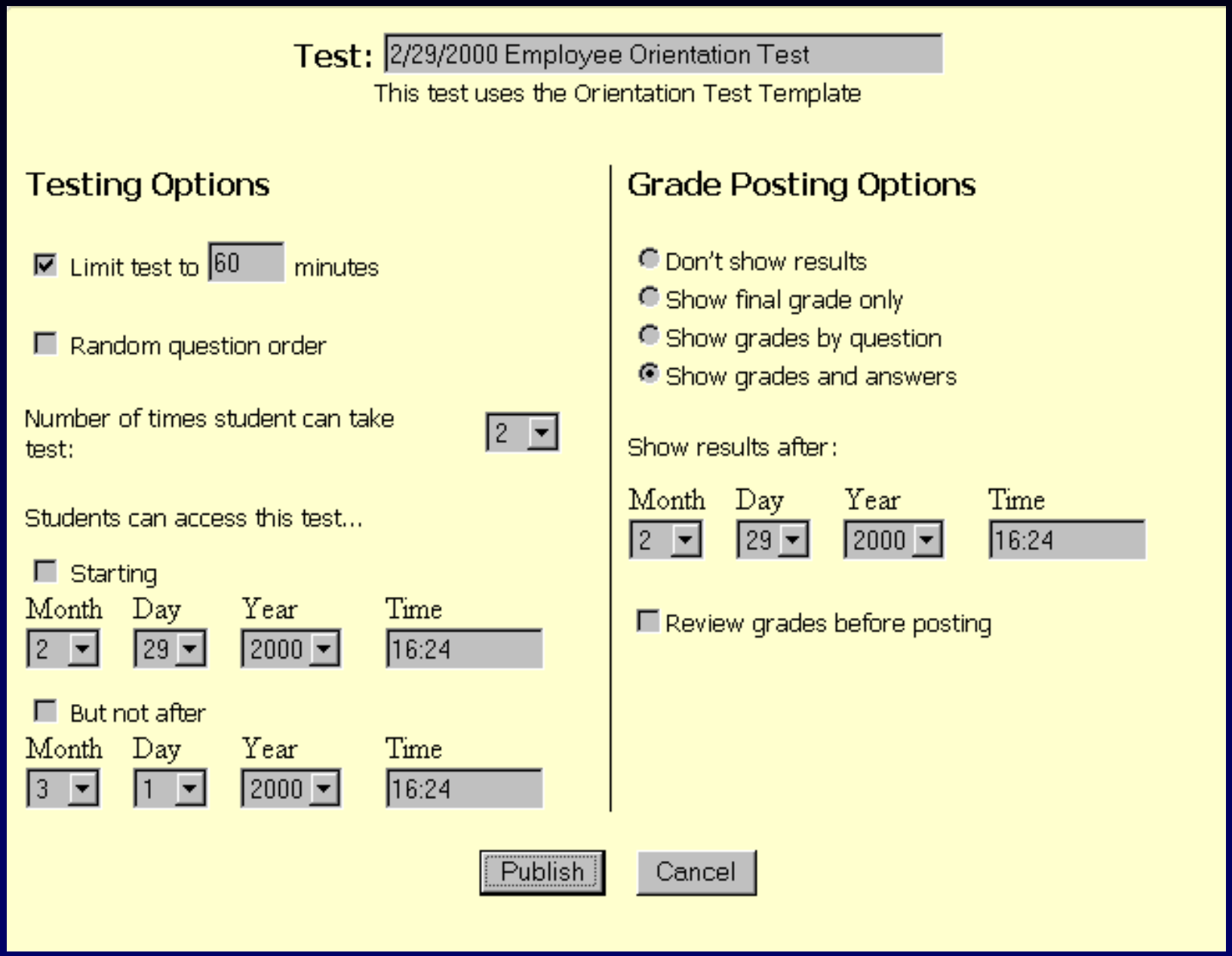






On-Line Testing (LearnLinc TestLinc)

eLearning



Student Results and Records

*e*Learning

Test: Office 2000 Overview

Karen Ling

Question	Correct Answer(s)	Student's Answer(s)	Points Available	Points Awarded
Microsoft Office 2000 includes which of the following standard software applications?	1. Word 2000 2. Excel 2000 4. FrontPage 2000	1. Word 2000 2. Excel 2000 4. FrontPage 2000	20	20
The "desktop" is a metaphor used to represent an important part of your computer's graphical user interface (GUI).	True	True	20	20
The Microsoft Office 2000 software application that you can use for word processing is called	Microsoft Word Word	Word	20	20
. Microsoft Excel, another Office 2000 software application, is used to create	spreadsheets forms graphs	graphs		
. To create your corporate intranet site, you could use	Microsoft FrontPage FrontPage	FrontPage		

Record book

eLearning

TESTLINC LearnLinc TESTING AND ASSESSMENT

Folder List

Virtual Campus

Help

Test: Office 2000 Overview

Click a student name to review individual test results.

Student	Date/Time Completed	Duration of Test (minutes)	Total Points	Awaiting Grade	
Arman Stattic	3/2/00 9:13:37 AM	1	80	No	Delete Result
Bernice Campollini	3/2/00 9:37:12 AM	5	60	No	Delete Result
Brian Mann	3/2/00 9:22:39 AM	8	100	No	Delete Result
Jude Sages	3/2/00 9:41:10 AM	1	80	No	Delete Result
Karen Ling	3/2/00 9:38:47 AM	0	100	No	Delete Result
Pamela Fraser	3/2/00 9:29:51 AM	2	73	No	Delete Result
Rumi Platek	3/2/00 9:42:58 AM	0	100	No	Delete Result

Done | View Statistics

Powered by LearnLinc

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The End