

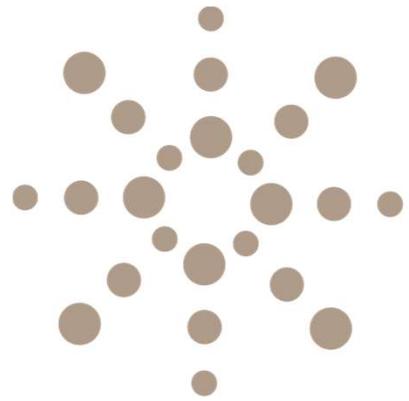
SERC Talks: “Not All Skills Are Created Equal: Agility and Innovation in STEM Education”

October 12, 2022 | 1:00 PM ET

Dr. Richard DeMillo,
Professor and Charlotte B. and Roger C. Warren Professor of Computing,
Chair, School of Cybersecurity and Privacy, Founding Director, C21U
Georgia Institute of Technology

INNOVATING STEM READINESS

- Today's session will be recorded.
- An archive of today's talk will be available at: www.sercuarc.org/serc-talks/ as well as on the [SERC YouTube channel](#).
- Use the Q&A box to queue up questions, reserving the chat box for comments, and questions will be answered during the last 5-10 minutes of the session.
- If you are connected via the dial-in information only, please email questions or comments to SERCtalks@stevens.edu.
- Any issues? Use the chat feature for any technical difficulties or other comments, or email SERCtalks@stevens.edu.



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R E S E A R C H C E N T E R



***SERC Talks: “Not All Skills Are Created Equal:
Agility and Innovation in STEM Education”***



Dr. Richard DeMillo

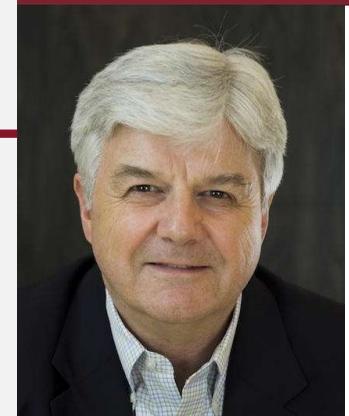
Professor and Charlotte B. and Roger C. Warren Professor of Computing,
Chair, School of Cybersecurity and Privacy

Founding Director, C21U

Georgia Institute of Technology

Moderator: Dr. William Rouse

SERC Research Council Member; Senior Fellow, Office of the Senior Vice President for Research,
McCourt School of Public Policy, Georgetown University



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NOT ALL SKILLS ARE CREATED EQUAL: AGILITY AND INNOVATION IN STEM EDUCATION

RICHARD DEMILLO
CHARLOTTE B. & ROGER C. WARREN PROFESSOR OF
COMPUTING
CHAIR, SCHOOL OF CYBERSECURITY AND PRIVACY
FOUNDING DIRECTOR, C21U
CREATING THE NEXT®

COMMISSION ON
CREATING THE NEXT
IN EDUCATION



DELIBERATE INNOVATION, LIFETIME EDUCATION



*Prepare students for 2040
when demographics, multiple
career paths, churn of
knowledge require episodic,
agile, intense lifetime
investment*



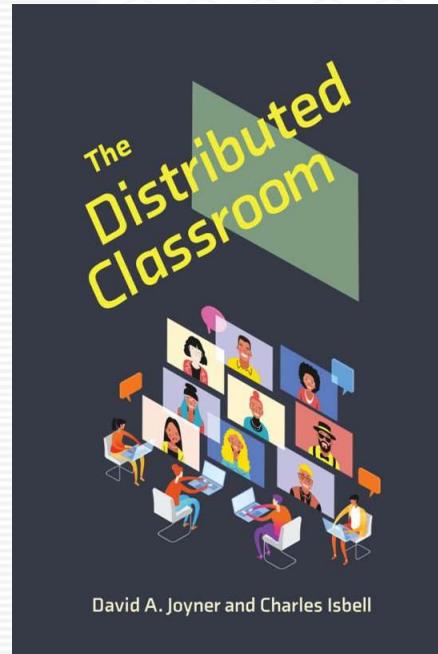
The Initiatives

Whole Person Education
New Products and Services
Advising for a New Era
AI and Personalization
Distributed Worldwide Presence

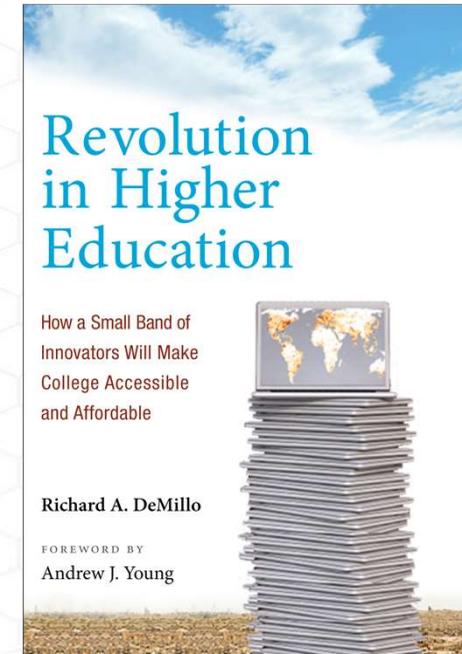


**The Culture –
Becoming
Deliberately
Innovative**

<https://dx.doi.org/10.2139/ssrn.3753524>



<https://mitpress.mit.edu/9780262046053/the-distributed-classroom/>



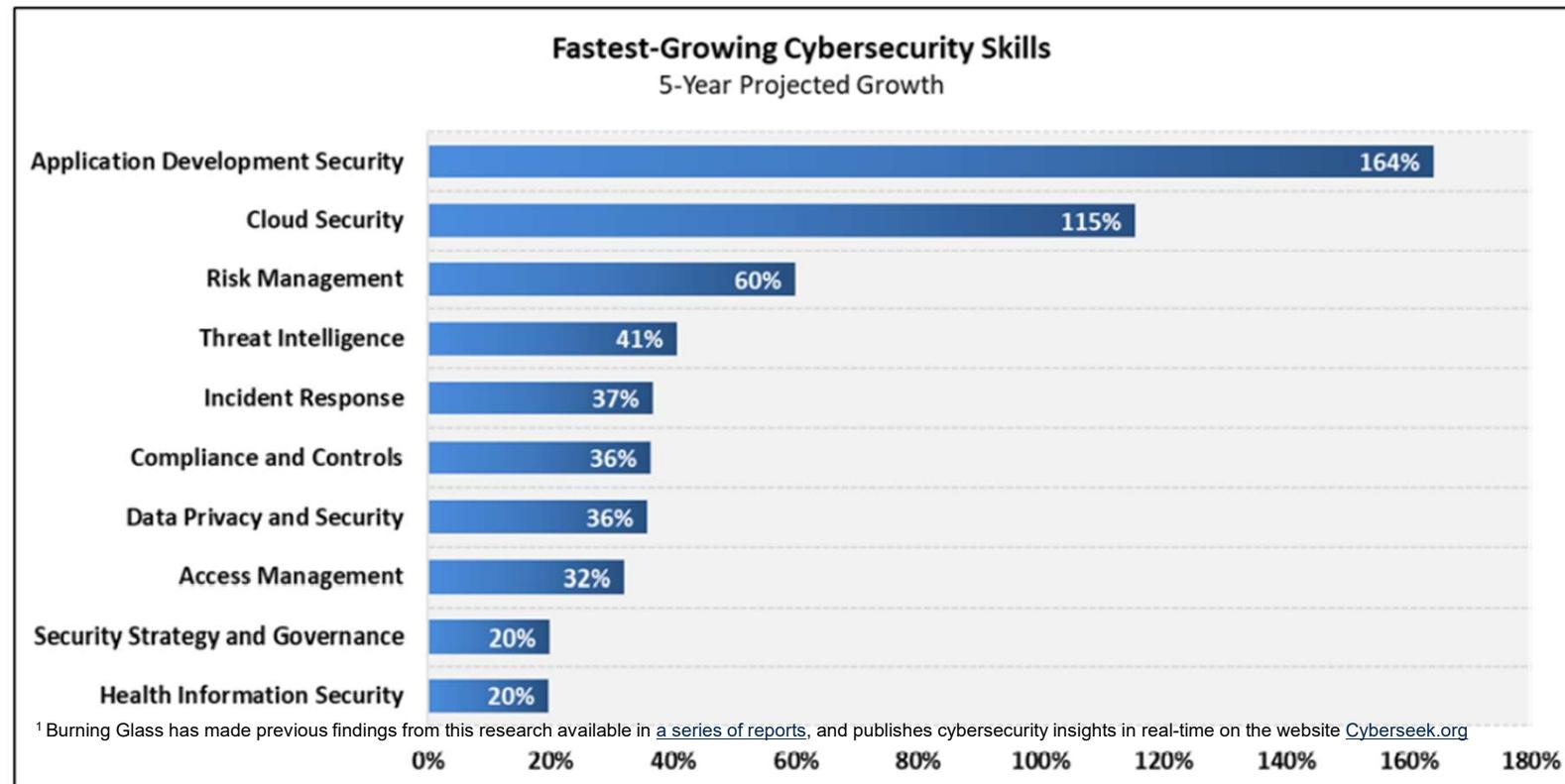
<https://mitpress.mit.edu/9780262533614/revolution-in-higher-education/>

SEPT 2020: I WAS ASKED TO CREATE A SCHOOL OF CYBERSECURITY AND PRIVACY AT GEORGIA TECH

WHAT ARE THE CYBERSECURITY SKILLS OF THE FUTURE?



Employers want cyber pros who can build secure infrastructure from the ground up



GROWING SKILLS COME WITH GROWING SALARIES



Skill	5-Year Projected Growth	Postings Oct. 2019-Sept. 2020	Salary Premium
Application Development Security	164%	29,635	\$12,266
Cloud Security	115%	19,477	\$15,025
Risk Management	60%	57,967	\$13,379
Threat Intelligence	41%	60,039	\$9,609
Incident Response	37%	23,497	\$5,683
Compliance and Controls	36%	54,770	\$12,423
Data Privacy and Security	36%	88,527	\$5,256
Access Management	32%	118,096	\$6,451
Security Strategy and Governance	20%	82,952	\$7,735
Health Information Security	20%	413,687	\$738

SKILL DRILL DOWN: APPLICATION DEVELOPMENT SECURITY

Total Openings

29,635

Average Salary
Premium

\$12,266

+164%

Projected 5-Year
Growth

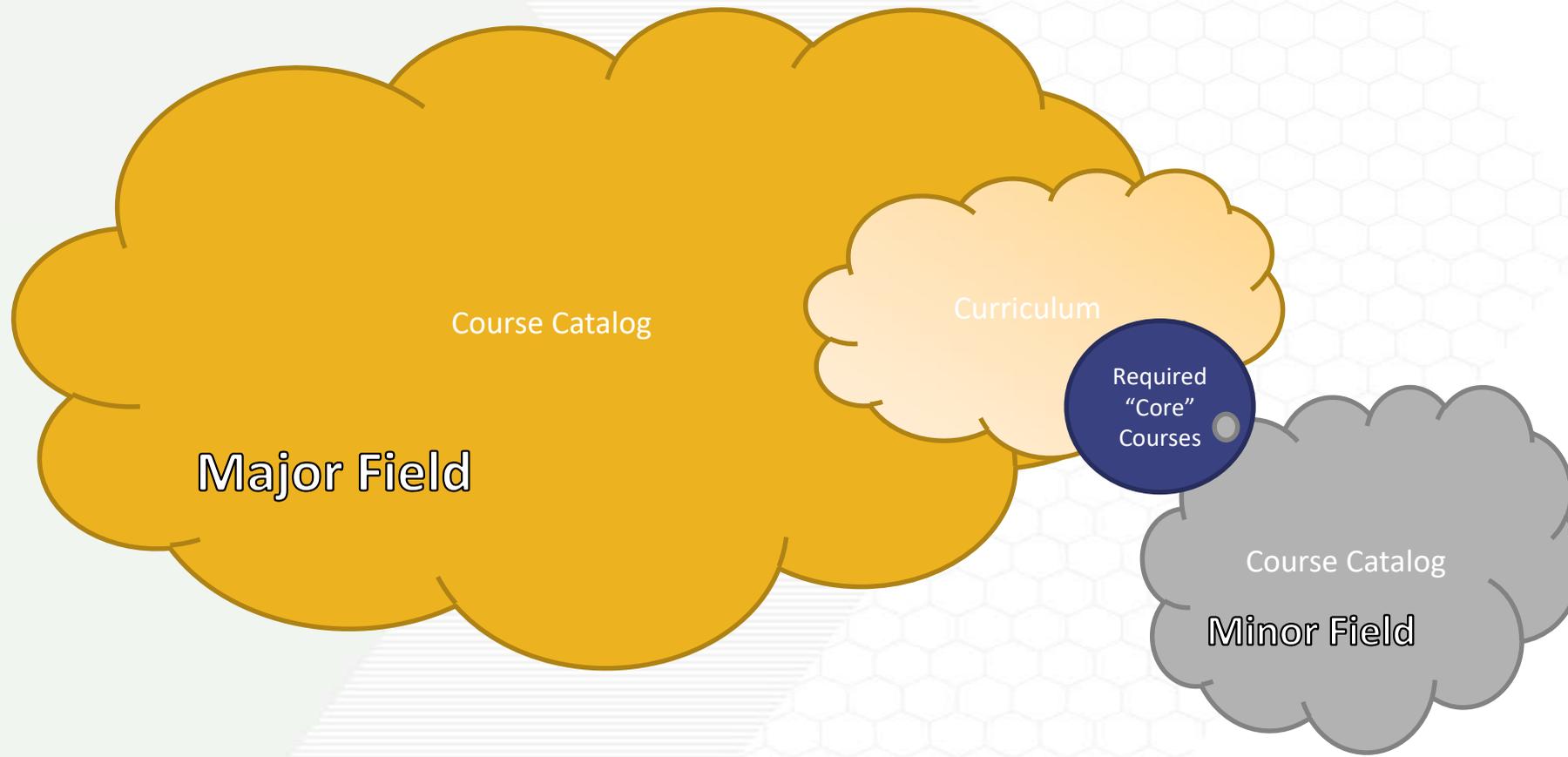
Key Specialized Occupations

1. **Software Developer**
2. **Cyber security Engineer**
3. **Systems Engineer**
4. **DevOps Engineer**
5. **Network Architect**

Fastest-Growing Skills

1. **DevSecOps (+174%)**
2. **Container Security (+155%)**
3. **Microservices Security (+113%)**
4. **Application Security Code Review (+43%)**

ACADEMIA IS PREOCCUPIED WITH SKILLS THAT TAKE DECADES TO EVOLVE



TO DISCOURAGE LEARNING, DESIGN SOMETHING LIKE THIS

- Mean value theorem – Kahn Academy vs Lecture 14
 - ✓ 30 concepts (every 2 minutes)
 - ✓ Homework that will not be graded until lecture 19. -- after the exam
 - ✓ Tyranny of content
- Most importantly: it's not how the brain learns
- The entire enterprise of higher ed is built around the long form lecture
- Almost nothing you think you know about rising HE costs is true
 - ✓ Not administrative bloat, lazy professors, or easy financial aid
 - ✓ 30% due to productivity stagnation
 - ✓ The rest due to
 - Macro economics
 - Bad governance
 - Stalled innovation



FIND PATHWAYS TO CHALLENGE EXISTING MODEL

Grounded Cognitive Learning

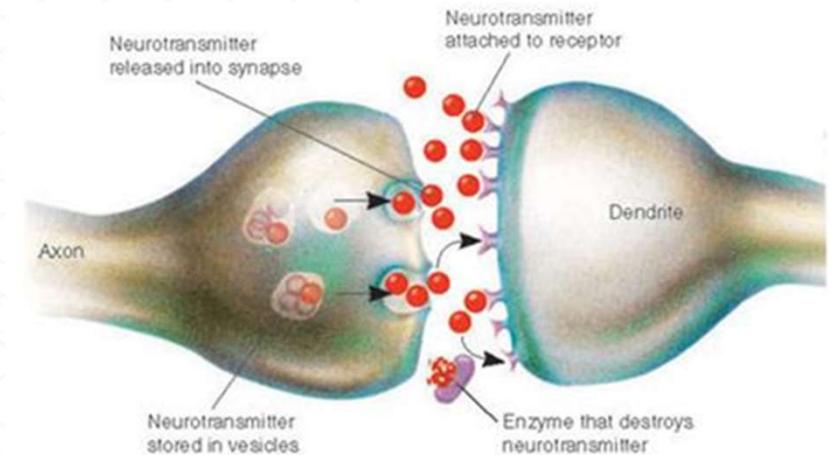
- Levity, brevity, repetition: learning and neurons – stimulus/reward cycle
- Not clear how to organize a classroom to promote this
- How to afford it?

Innovative Non-Cognitive Learning

Testable

- “Almost nothing you believe is important matters...”
- Human teachers have almost no impact compared to
 - Formative assessment
 - Chunking
 - Rapid feedback

Physiological change in the brain	Effect on behavior	What we see in our classes	What we can do to foster appropriate growth
There is tremendous overproduction of neurons, dendrites and synapses Followed by pruning (elimination) of unused neurons, dendrites, and synapses. Details: The neural connections made by emerging adult brains last a lifetime; they become “hard wired.”	Emerging adult brains are fascinated by, and seek out, novelty and emotion; they value surprise and unpredictability. Emerging adults also crave structure and organization, in spite of their attraction to novelty. The things they spend time on (good or bad) influence what they do now.	Short attention span Like to be entertained Ask for lots of specific guidance (seem not to be independent)	Provide short breaks Use new ideas and techniques Don't get too predictable <u>but</u> do provide structure and guidelines Give quick feedback Be explicit Model behaviors you'd like to see in students



2012 MOOC EXPLOSION

Most people focused on free, big

We focused on the Iron Triangle

- Role of productivity in rising cost
- Role of communications in access
- Role of technology in achievement

We invested in using the technology to make mastery learning feasible

- MOOC is not a videotaped lecture – it is designed to align with how the brain learns
- We studied this

Online Masters in CS (OMSCS)

- Highly ranked degree
- Less than \$7,000
- Largest CS graduate program in the world
- Expanded market for graduate education in CS by 8% pa

MANY OF THE 2011 GOALS BECAME SUCCESSFUL PROJECTS



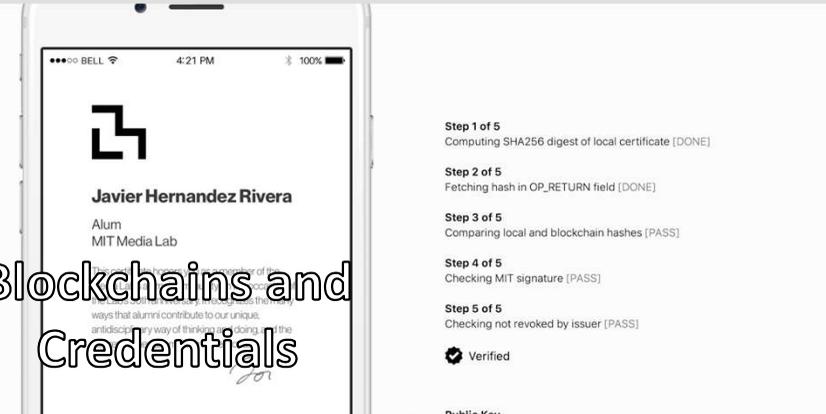
Python

- **Dynamic & Interpreted**
 - Runs code line by line
- **Scripting Mode**
 - Runs all at once

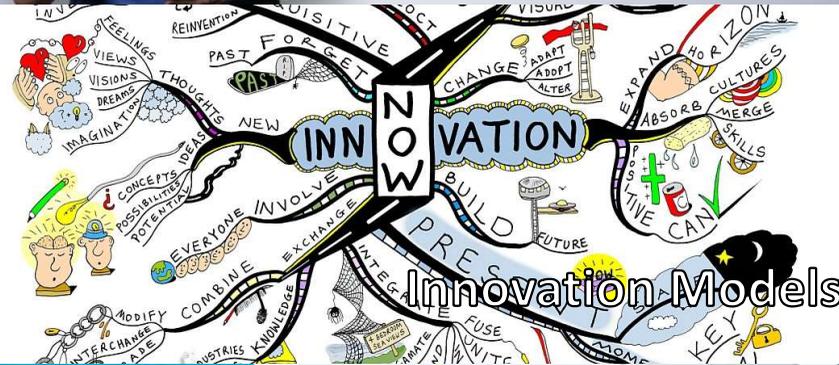
New credit delivery



Calibrated Peer Assessment



Blockchains and Credentials



Innovation Models

I, Blended, Flipped, and Inverted: Defining Terms in a Two Dimensional Taxo

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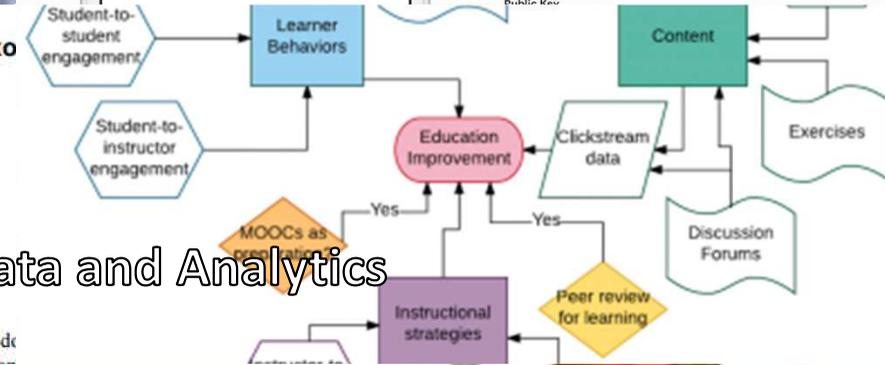
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Flipped Classrooms

Data and Analytics



Plotting integers on a number line

CONTINUE MY PATH

WORKING TOWARD

Chapter 3 - Linear Equations in Two Variables
1 of 55 Topics
Due: Jul 3 11:59 PM

Time Goal
2h 30m
Due: Jul 3 11:59 PM

WORK ON SOMETHING ELSE

Quiz 2
Due: Jul 3 11:59 PM
Attempts: 0 of 3 Remaining

Homework 3

311

- Arithmetic Readiness (59 Topics)
- Real Number (39 Topics)
- Linear Equations (29 Topics)
- Functions and Lines (83 Topics)
- Systems (20 Topics)
- Exponents (47 Topics)
- Polynomials and Factoring (17 Topics)
- Radicals (29 Topics)
- Rational Expressions (29 Topics)

Changing Demographics

lyBoard: Meet Your Own Personal board (Edited Feb 27th)

New Pedagogy



Applications
AS OF Fall2020

37,498



of Countries
REPRESENTED

100+



Enrollment
AS OF Fall2020

10,559



Graduates
AS OF Fall2020

3,795

- Fall 2020 New Enrollment: 2,890
- Overall Enrollment: 10,799
- U.S. Citizens & Residents (% of Enrollment): 63.4%
- International Students: 36.6%
- Men: 81%
- Women: 19%
- Underrepresented Minorities: 11.3%
- Total Course Enrollments : 14,347 ←
- Countries Represented: 122
- U.S. States/Territories Represented: 53
- Companies Represented: 3,000+

Georgia Tech College of Computing

ONLINE MASTER OF SCIENCE IN COMPUTER SCIENCE

Offered in collaboration with Udacity and AT&T



HOW TO CHANGE HE FROM WITHIN

Change in faculty attitudes

Cannot be top down

Value of small projects

Need to find trimtabs

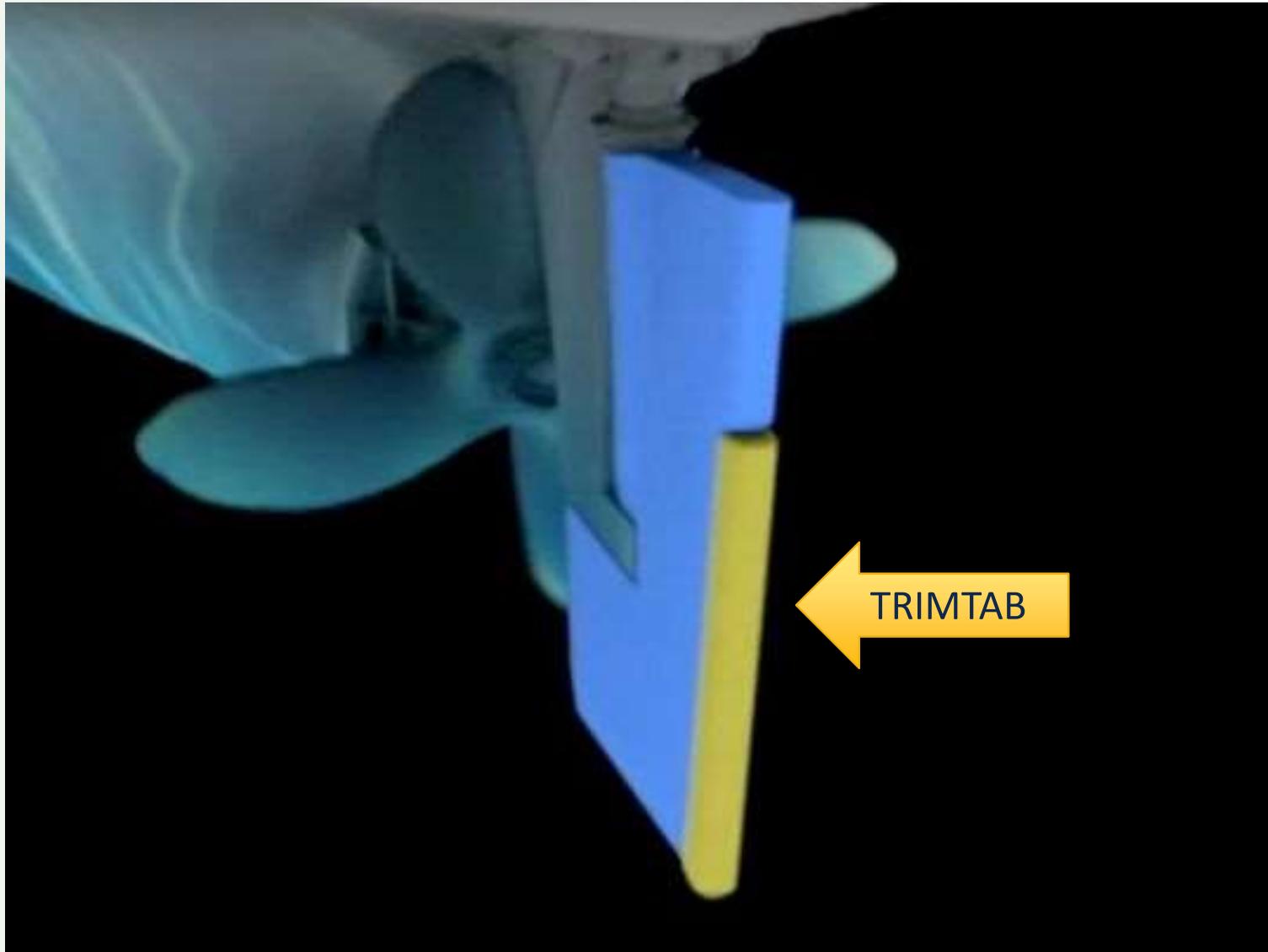
Alignment

But...

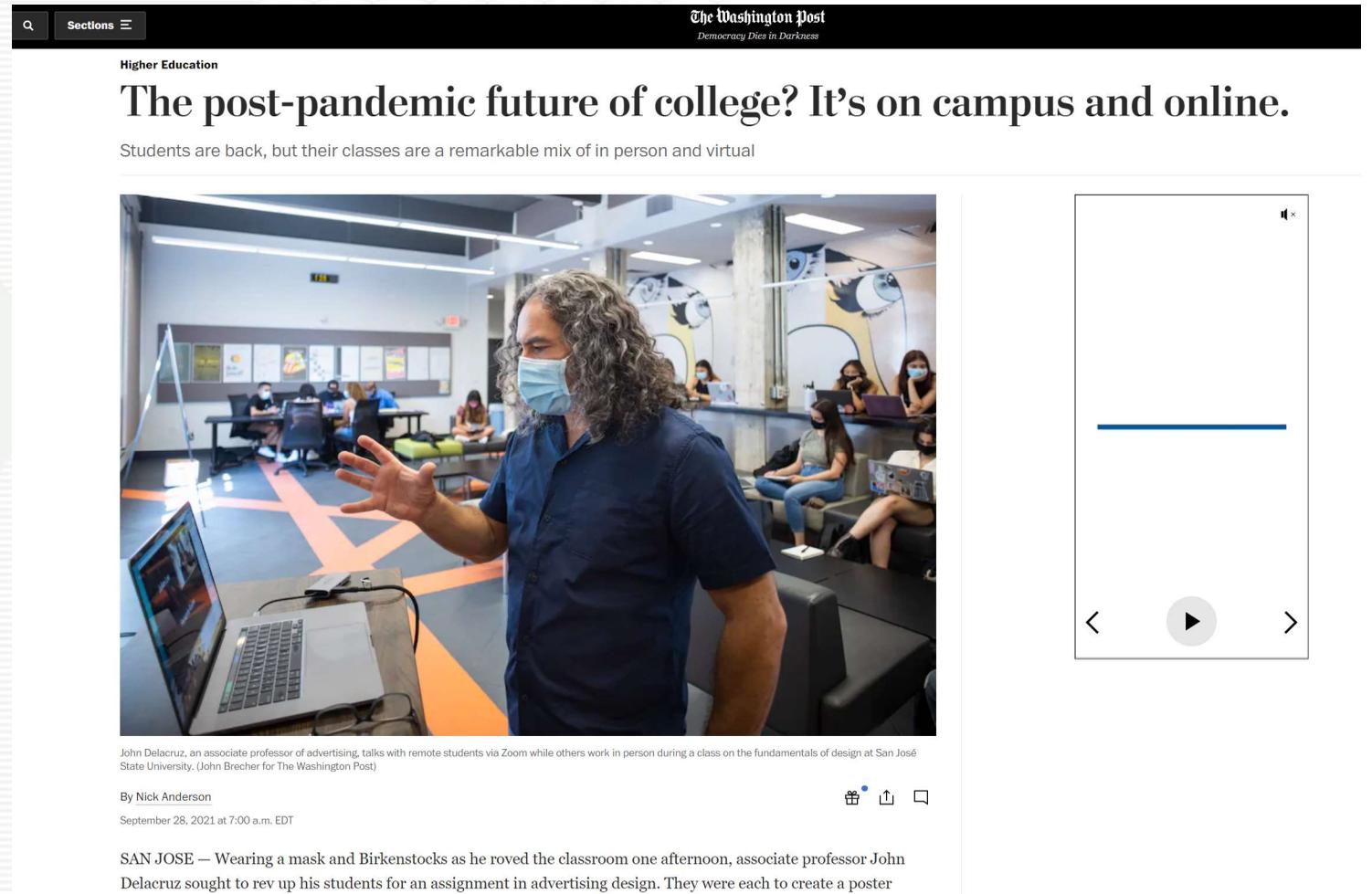
Current business models are threatened

TRIMTAB IS A METAPHOR....





- Distributed classroom advantage
- Organized resistance to online learning disappeared
- Pandemic pause button
- Enrollment spike
- Slower pace of change
- Scaling strategy stressed



The Washington Post
Democracy Dies in Darkness

Higher Education

The post-pandemic future of college? It's on campus and online.

Students are back, but their classes are a remarkable mix of in person and virtual



John Delacruz, an associate professor of advertising, talks with remote students via Zoom while others work in person during a class on the fundamentals of design at San José State University. (John Brecher for The Washington Post)

By Nick Anderson
September 28, 2021 at 7:00 a.m. EDT

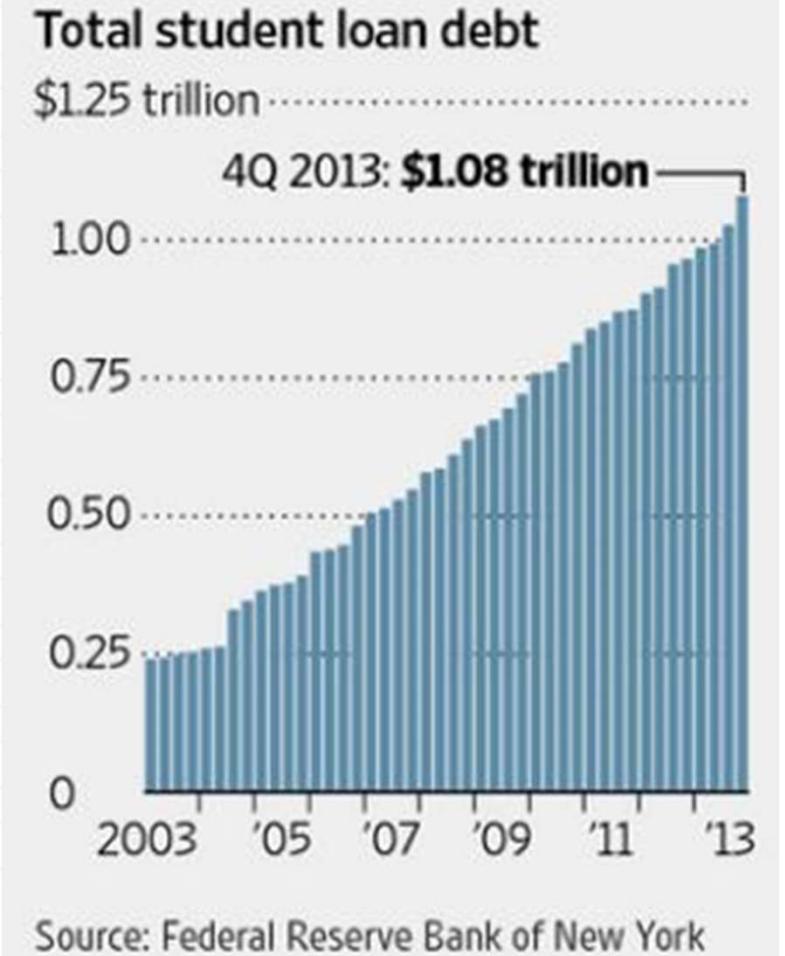
SAN JOSE — Wearing a mask and Birkenstocks as he roved the classroom one afternoon, associate professor John Delacruz sought to rev up his students for an assignment in advertising design. They were each to create a poster

AFTER THE REVOLUTION

Infighting over online delivery is dead

Topical issues

- Student loan debt forgiveness: does not cost taxpayers
- “Not everyone needs a college degree” is true but you’re better off with a degree
- Major cost of college increases not addressed at all
 - “Cost disease”
 - “Revenues cap spending”
- The world is interdisciplinary



***“The thing that I was most concerned by, the fact that I have no contact with the students and that it will feel detached, turned out completely untrue — between Piazza, live office hour sessions, and all, I end up seeing more of the students, and they end up seeing more of me, compared to anything I’ve experienced on campus before.*”**

*I may not know their gender or race (Bobbie turns out is female, and Estelle Yeh isn’t a Chinese girl with a western name but a French girl with a Thai husband ;)), but I know exactly how much they know and how they’ve had amazing progress through the semester, from virtually no C skills and ready to drop out, to getting a strong A and getting hired as TAs the following semester. And they are not the exception, lots more stories like this. *It comes at a great cost in time*, not as bad once recording is done, but still comparable time effort as when teaching a regular class. I expected it would be less, since the lecture part wasn’t there. But I feel that *what makes the experience so positive for the students, is that we, the Instructors, do remain very much engaged with the class.* And given that it’s real money and real degrees at stake, you cannot not do it.”*

-- GT Professor

CHALLENGE FOR THE FUTURE – CONFRONT COMPLEXITY OF THE 21ST CENTURY

We've spent nearly 20 years solving 16th century problems – stop thinking of higher education as a regulated industry

Plan for 2040, when

- demographic changes,
- educational reform in K-12,
- alumni who by choice follow multiple careers paths over their lifetime, and
- a workplace where the churn of knowledge must be continually renewed

requires

- episodic,
- agile,
- intense
- engagement with younger learners that continues throughout their lives.

HOW DID THE UNIVERSITY ORGANIZE FOR INNOVATION?

- Have a philosophy for change
 - Have a sense of the future
 - Anecdotes and gut feelings no match for data
 - Don't start with the current state
 - Don't fight the existing order, make it obsolete
- Be realistic: Universities can diversify but they can't become different creatures
- No artificial time constraints
- Don't fall for the curse of too much money
- Importance of culture

**“YOU NEVER CHANGE SOMETHING
BY FIGHTING THE EXISTING REALITY.
TO CHANGE SOMETHING
BUILD A NEW MODEL
THAT MAKES THE EXISTING MODEL OBSOLETE.”**

-R. Buckminster Fuller



CHURN OF KNOWLEDGE

- Globalization & Collapse of Disciplines
- Digital Transformation
- 100 Year Life

SCIENCE & TECHNOLOGY OF EDUCATION

- Cognitive Science & Behavioral Economics
- Ascendance of Data
- Convergence of technologies

GATSBY CURVE: INTERGENERATIONAL WEALTH ELASTICITY

- Affordability
- Character Values
- Non-Cognitive Malleability

COMMISSION ON
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IN EDUCATION



DISCUSSION



ANNUAL

RESEARCH

REVIEW

2022

REGISTRATION OPEN

National Press Club, Washington DC (Hybrid)

November 15-17, 2022

More details on event webpage: <https://sercuarc.org/research-reviews/ssrr-2022/>



John V. Lombardi, Ph.D,
Professor Emeritus, University of Massachusetts Amherst
Michael Gargano, Jr., Ed.D,
CEO, The Education Think Tank
Wednesday, November 9, 2022 | 1PM ET



**“Innovating for STEM Readiness” Series Moderator:
Dr. William Rouse, SERC Research Council Member, Georgetown University**

CONTACT

Webinar Coordinator: Ms. Mimi Marcus, Stevens Institute of Technology – mmarcus@stevens.edu

Please visit the [SERC Talks page](#) to register and for more information and updates.



SYSTEMS
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