Preparing Student for a Global Science, Engineering, and Education Workforce

Peter Arzberger
27 July 2012
Monash University Research Program Abroad
Congratulations!

5\textsuperscript{th} year of MURPA
9\textsuperscript{th} year of PRIME
Personal Background

- Undergraduate: Mathematics, U Massachusetts
  - Year Abroad: Freiburg Germany
- Actuary in Insurance Company
- Another year in Germany: Giessen
- Graduate School: Purdue University
  - Mathematics: Applied to Populations Genetics, Used computer
- Rochester Institute of Technology
- University of Wisconsin: Statistics
- National Science Foundation (88-95; 09-11)
- San Diego Supercomputer Center and UCSD
- International Activities
  - Global Biodiversity Information Facility
  - International Long Term Ecological Research
  - Organization of Economic Cooperation and Development
- PRAGMA, GLEON, NBCR, PRIME
Overview of Discussion

• Part 1: Challenges, Trends, Opportunities
• Part 2: Examples of International Activities With relevance to MURPA projects
• Part 3: Programs for our future leaders
  – Ideas for schools and students.
Issues Facing Global Society

Living Beyond Our Means
Natural Assets and Human Well-being

March 2005

Toward Sustainable Agricultural Systems in the 21st Century

Science December 14, 2007

Dengue Fever
Prosperity Bug

A neglected tropical disease affects 1 billion people;
1% new drugs for NTD (1975-99)
Commonalities

• Solutions involve science, technology, policy, and people

• Cross many boundaries
  – Disciplinary, Governmental, Economic Strata

What are the trends in science?
Shifting Landscape of Science

- Significant shifts in funding geographically
  - Flat budgets in US/EU, increasing budgets in Asia

- Increases in collaborations (pubs)

**Publications Analysis**
All data compiled by Science-Metrix from the Web of Science (Thomson Reuters). Country key applies to all figures.

- EU-27
- United States
- China
- Korea
- Netherlands
- Switzerland
- Denmark
- Singapore

**FIGURE 4**
International collaboration, 1980-2009

Note: The percentage of international collaboration is calculated by dividing the number of papers co-authored with at least one foreign institution by the total number of papers.
Science: Increasingly global, collaborative, distributed

- The architecture of world science is also changing, with the expansion of global networks.
- International activities and collaboration should be embedded in national science and innovation strategies.
- The primary driver of most collaboration is the scientists themselves.

“intellectual power [is] becoming increasingly evenly distributed”
N. Birdsall, F. Fukuyama

Knowledge, Networks and Nations: Global scientific collaboration in the 21st century.
The Royal Society. March 2011
Age of Observation: Smart Sensing, Reasoning & Decision Control

Environment Sensing

Percepts (sensors) -> Agent (Reasoning) -> Actions (controllers)

Personal Sensing

Public Sensing

Social Sensing

People-Centric Sensing

Emergency Response

Situation Awareness: Humans as sensors feed multi-modal data streams

Social Informatics

Sense

Identify

Assess

Intervene

Evaluate

Informatics

Smart Hearth Care

Source: Sajal Das, Keith Marzullo
Dealing with Data

http://www.sciencemag.org/site/special/data/

http://www.economist.com/node/15579717

International Impact
On Science and Society
International Competency and Opportunity

• What nations don’t know can hurt them. The stakes involved in study abroad are that simple, that straightforward, and that important. ... college graduates today must be internationally competent.”

• Your pursuit of the biological and behavioral sciences should indeed improve the competitiveness of the United States. But, if you pursue international research experiences and opportunities, you will contribute substantially to your own development as scientists and that of the nation.
Institute for International Education
“Opening Minds to the World”

Peace and prosperity around the world depend on increasing the capacity of people to think and work on a global and intercultural basis.

- Recent report on percentage of US students abroad
  - Engineering: 10,554
    - 3.9% of total
  - Math and CS: 4,059
    - 1.5% of total abroad

- Percent of study approach to total US student population
  - US higher ed: 1.4%
  - US undergrad: 9.5%
  - US undergrads pursuing degrees: 14.0%
Part 2:  
Examples of International Activities With Relevant to MURPA projects

PRAGMA 22
17 – 19 April 2012
Monash University
Pacific Rim Application and Grid Middleware Assembly
PRAGMA: 10 Years of Collaboration and Experimentation

- Built and used multi-provider cloud testbed
- Driven development via Scientific Expeditions
- Engaged new groups

PRAGMA 20 at HKU
Centennial Celebration
March 2011
Infrastructure Accomplishments

- Built testbed
  - Used testbed to conduct experiments, test software
- Developed approach to migrate images, multiple hosting environments

PRAGMA's multi-provider cloud. GFarm is a strongly authenticated VM repository.
Scientific Expeditions
Evaluate and Address Needs of the Science

OSG Grid Interoperability Experiment 2007

Savannah Burn 2006

Distribution of ash from the Irazu volcano 2010

VM Migration Experiment 2011
Disaster Recovery of Key Services

• Massive earthquake and resulting tidal wave was devastating for Japan, AIST systems out of service
  – NCHC, SDSC/UCSD, other institutions in Japan, and U Chicago (R Grossman) assistant, migrate services

• Can PRAGMA members provide infrastructure to other members for this type of persistence of key services at a time of disruptions?
From Scientific Expedition to Community Building on NCHC Ecogrid

8 Months: Concept to Deployment

- Science
- Need more than one lake to understand processes

Date
- 22-Aug
- 23-Aug
- 24-Aug
- 25-Aug
- 26-Aug
- 27-Aug
- 28-Aug

Water Temperature (°C)

Precipitation (mm per 5 minute interval)

Surface
- 0.5 meters
- 1 meter
- 1.5 meters
- 2 meters
- 2.5 meters
- 3 meters

8 Years Later
PRAGMA Advances by Participants’ Collaborative Activities

- GEO Grid: Hosted PRAGMA 21
  - Led by AIST, involving NCHC, NECTEC, VAST/IOIT
- Ezilla: NCHC
- OpenFlow: Applying it by Osaka
- Gfarm: U Tsukuba
- Duckling, CNIC/CAS
- My Gallery: Cultural Heritage Display, e.g., NICT, UCSD, MoPA
- KLEON and KEON, Konkuk and others
- Many more
Building on What We’ve been working on together: VMs + Overlay Networks + Data; Infrastructure Developments

- Data Sharing, Provenance, Data Valuation and Evolution Experiments:
  - Beth Plale, Indiana U
- Overlay Networks, Experiments with IPv6 10
  - Jose Fortes, Renato Figueiredo, U Florida
- VM Mechanics Multi-Site, Multi-Environment VM Control and Monitoring
  - Phil Papadopoulos, UCSD
- Sensor Activities: From Expeditions to Infrastructure
  - Sameer Tilak, UCSD
Future Scientific Expeditions

Proposed - Persistent

• Biodiversity
  – Understanding Adaption in Extreme Ultramafic Regions: Reed Beaman U FL

• Lake Science:
  – Predicting Impact of Eutrophication on Lake Ecosystem Services: Paul Hanson, U Wisconsin

• Drug Discovery:
  – Focusing on Infectious Diseases: Wilfred Li, UCSD

What Others?

• Disaster Mitigation
• Cultural Heritage Sharing
• Many others

NSF Proposal
I. Prepare occurrence dataset
   II. Post occurrence set
   III. Post experiment

(1) A script queries GeoPortal instance at UTM (Malaysia) to retrieve raster data
(2) Retrieves raster data from stored dataset
(3) Submit dataset to LifeMapper as occurrences/experiments
   I. Prepare occurrence dataset
   II. Post occurrence set
   III. Post experiment
(4) LifeMapper outputs prediction result as metadata (EML)
(5) Catalogs LifeMapper predicted output metadata in GeoPortal at IU (US)

Graduate students key to this Scientific Expedition

Source: Uma Pavalanthan
Infusing New Ideas: Strategic Partners

• Growth in the past was mostly “community” driven
  – SEAIP (Southeast Asia Institute International Joint Research and Training Program in High-Performance Computing Applications and Networking Technology) with the PRAGMA Institute

• For our future, we need to consider expertise, impact, and growth opportunities
  – New technology areas: Based on needs and areas we did not have represented
  – New scientific expeditions: Exciting science, opportunity to engage more scientists, build communities
  – New institutions/regions to engage
  – New participants
  – Students!: PRIME, GSA
    • Building on PRIME
    • Using GLEON model for students

NSF Proposal
For this type of international and network science

Are our education programs and experiences creating the future leaders?
Experiential Learning

• Augmentation of Undergraduate Experience
• Contributing to the academic, intellectual, and social growth of young people

“PRIME prepares a future generation of science and engineering leaders, who have the cultural competency and the skill sets to compete successfully in the global workplace, by engaging students in an immersive, hands-on international educational experience, with a focus on research that contributes to real-world challenges”
“PRIME prepares a future generation of science and engineering leaders, **who have the cultural competency and the skill sets to** compete successfully in the global workplace, by engaging students in an immersive, hands-on international educational experience, with a **focus on research that contributes to real-world challenges**”
PRIME – Developing Technologies

• Augmented Reality in Android System with a Disaster Response Application
  – Prototype of use of “every day” devices to integrate realtime data onto previous reality
  – NCHC: Fang-Pang Lin

• Navi: Covise-Kinert Navigation Interface with Cultural Heritage Application
  – NICT, Osaka: Shinji Shimojo

• Integration of the Opal Web Service Client into the Duckling Portal
  – Resulted from PRAGMA 20 discussion
    – CNIC: Kevin Dong
    – Demo
PRIME – Imaging and Databases

• Imaging in heart muscle
  – Auckland: C. Soeller

• Automatic image classification in wasps
  – Taiwan Forest Research Inst.
  – CC Lin

• Database development on damage in NZ
  – Auckland: L. Weatherspoon
PRIME – Bioscience Modeling

• Modeling in cardiac myocytes
  – Monash U: D Abramson

• Virtual screening, protein model building, influenza virus research
  – Osaka; CNIC, USM, Nat. Taiwan U (S. Shimojo, K Nan, H Wahab, JH Lin)
<table>
<thead>
<tr>
<th>Name</th>
<th>Project Description</th>
<th>Institution</th>
<th>Mentor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liang Ding</td>
<td>Parallel reduction tree based debugging in Eclipse</td>
<td>NCSA</td>
<td>Jay Alameda</td>
</tr>
<tr>
<td>David Warner</td>
<td>Automatically Assigning Academic Reviewers to Papers</td>
<td>Technion</td>
<td>Shaul Markovitch</td>
</tr>
<tr>
<td>Thomas Moore</td>
<td>An automated approach for the systems definition of ad hoc wireless sensor networks</td>
<td>UCSD</td>
<td>Sameer Tilak</td>
</tr>
<tr>
<td>John Bell</td>
<td>Increasing utility of and awareness in SciVee</td>
<td>UCSD</td>
<td>Philip Bourne</td>
</tr>
<tr>
<td>Satvik Kumar</td>
<td>Extending GSOM to HPC systems</td>
<td>UCSD</td>
<td>Robert Sinkovits</td>
</tr>
<tr>
<td>Minh Ngoc Nhat Huynh</td>
<td>Approaches to author Rocks virtual machine in Amazon Elastic Compute Cloud</td>
<td>UCSD</td>
<td>Philip Papadopoulos</td>
</tr>
<tr>
<td>Victoria Weldon</td>
<td>Prediction and Validation for Patient-Specific Cardiac Models</td>
<td>UCSD</td>
<td>Roy Kerckhoffs</td>
</tr>
<tr>
<td>Date</td>
<td>Speaker</td>
<td>Topic</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>27 July 2012</td>
<td>Dr Peter Arzberger (UCSD)</td>
<td>Preparing Students for a Global Science, Engineering, and Education Workforce</td>
<td></td>
</tr>
<tr>
<td>3 August 2012</td>
<td>Professor Phil Bourne (UCSD)</td>
<td>New modes of Scholarly Communication in the Digital Age</td>
<td></td>
</tr>
<tr>
<td>10 August 2012</td>
<td>Dan Fay (Microsoft)</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>17 August 2012</td>
<td>Dr Beth Simon (UCSD)</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>24 August 2012</td>
<td>Dr Ilkay Altintas (SDSC)</td>
<td>Distributed Workflow-Driven Analysis of Large-Scale Biological Data using bioKepler</td>
<td></td>
</tr>
<tr>
<td>31 August 2012</td>
<td>Dr Sameer Tilak (UCSD)</td>
<td>TBA: Sensing and the Environment</td>
<td></td>
</tr>
<tr>
<td>7 September 2012</td>
<td>TBA</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>14 September 2012</td>
<td>Dr Robert Sinkovits (SDSC)</td>
<td>TBA: HPC and Computing Platforms</td>
<td></td>
</tr>
<tr>
<td>21 September 2012</td>
<td>Professor Larry Smarr (UCSD)</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>5 October 2012</td>
<td>Krishna Charavarthi Madhavan</td>
<td>TBA</td>
<td></td>
</tr>
<tr>
<td>12 October 2012</td>
<td>Jay Alameda (NCSA)</td>
<td>TBA</td>
<td></td>
</tr>
</tbody>
</table>
Part 3: Programs for our future leaders
Ideas for schools and students.

• Lessons Learned
• Liberal Education & America’s Promise (LEAP)
• Institute for International Experiential Learning or PRIME 2.0
Ask the Right Question

• Why don’t you take advantage of your location, on the Pacific Rim, and create deep collaborations by working with others in the this region?
  – W.Y. Bill Chang
Ask the right question

• With all of our technologies, how do we apply them to important problems?
  – Fang-Pang Lin, NCHC, April 2003
Telescience/BIRN Portal was Quickly Adapted to a SARS Portal for Taiwan

Source: Fang-Pang Lin
Ecogrid: An Outgrowth of PRAGMA Telescience
Ask the Right Question

• If we can connect two lakes, why can’t we connect more?
  —Tim Kratz, 2004
Ask the Right Question

• How do we structure partnerships to succeed?
  – Philip Papadopoulos
Ask the Right Question

• How can we prepare students for the new world of global research and societal challenges, synthesis, virtual communities, and a global interconnected economy?
  — Gabriele Wienhausen
Ask the Right Question

• How do we provide our expertise to those in our society eager to learn but without the means?
• PRIME students working with elementary and middle school age students in rural Malaysia, learning firsthand through their Universiti Sains Malaysia mentor the need for scientists to reach out to their communities and improve education, especially in the Science, Technology, Engineering, and Mathematics (STEM) area (July 2008).
Earth in the Mind
On Education, Environment, and the Human Prospect
David W. Orr

• Where does your field of knowledge fit in the larger landscape of learning?
• Why is your particular expertise important? For what and for whom is it important?
• What are its wider ecological implications and how do these affect the long-term human prospect?
• Explain the ethical, social, and political implications of your scholarship.
Lessons Learned

• Ask the right question
• Anticipate the trends
• Pursue your passion
• Build your personal network and trust
• Collaborate with those you like
• Develop your “soft skills”
Characteristics of Scientific Leaders

• Communicate concepts, and articulate a vision
• Build teams
• Mentor and develop new talent
• Understand culture
• Celebrate diversity of people and thought
• Motivate people to excel

Which scientific or engineering discipline gives undergraduates this skill set?
Liberal Education & America’s Promise

Excellence for Everyone as a Nation Goes to College

“A COLLABORATION BETWEEN EDUCATORS AND EMPLOYERS”

www.aacu.org/LEAP
Narrow Learning is Not Enough!

The LEAP Essential Learning Outcomes

• Knowledge of Human Cultures and the Physical and Natural World
  Focused on engagement with big questions, enduring and contemporary

• Intellectual and Practical Skills
  Practiced extensively across the curriculum, in the context of progressively more challenging problems, projects, and standards for performance

• Personal and Social Responsibility
  Anchored through active involvement with diverse communities and real-world challenges

• Integrative Learning
  Demonstrated through the application of knowledge, skills, and responsibilities to new settings and complex problems
Balance of Broad Knowledge and Specific Skills Preferred

Which is more important for recent college graduates who want to pursue advancement and long-term career success at your company?

- Broad range of skills and knowledge that apply to a range of fields or positions: 20%
- In-depth knowledge and skills that apply to a specific field or position: 20%
- BOTH in-depth AND broad range of skills and knowledge: 59%

“Raising the Bar: Employers’ Views on College Learning in the Wake of the Economic Downturn” (AAC&U and Hart Research Assoc. 2010)
## Employers’ Top Priorities for Student Learning Outcomes in College

% saying two- and four-year colleges should place MORE emphasis on helping students develop these skills, qualities, capabilities, knowledge

<table>
<thead>
<tr>
<th>Skill/Quality</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective oral/written communication</td>
<td>89%</td>
</tr>
<tr>
<td>Critical thinking/analytical reasoning</td>
<td>81%</td>
</tr>
<tr>
<td>Knowledge/skills applied to real world settings</td>
<td>79%</td>
</tr>
<tr>
<td>Analyze/solve complex problems</td>
<td>75%</td>
</tr>
<tr>
<td>Connect choices and actions to ethical decisions</td>
<td>75%</td>
</tr>
<tr>
<td>Teamwork skills/ability to collaborate</td>
<td>71%</td>
</tr>
<tr>
<td>Ability to innovate and be creative</td>
<td>70%</td>
</tr>
<tr>
<td>Concepts/developments in science/technology</td>
<td>70%</td>
</tr>
</tbody>
</table>

“Raising the Bar: Employers’ Views on College Learning in the Wake of the Economic Downturn” (AAC&U and Hart Research Assoc. 2010)
High Impact Practices

Through the LEAP initiative, AAC&U has published research on a set of widely tested teaching and learning strategies and programs that—when done well—have substantial educational benefits, especially for traditionally underserved students. The elements of good teaching and learning embedded in these practices can be applied in many settings, including in traditional classrooms as well as special programs, and in co-curricular settings.

- First-Year Seminars and Experiences
- Common Intellectual Experiences
- Learning Communities
- Writing-Intensive Courses
- Collaborative Assignments and Projects
- Undergraduate Research
- Diversity/Global Learning
- Service Learning, Community-Based Learning
- Internships
- Capstone Courses and Projects
PRIME 1.0 Learning Model

Research Apprenticeship
Joint Mentors @ UCSD & Host site

Undergraduate Students

Cultural Competency

Professional

Pre-departure Training

Weekly Questions

Post-return debrief

Career Advice

Outputs & Outcomes

Research Experience

Collaborations

Publications

Software

Host-site researchers

Cultural Awareness

Globally Aware Workforce

Inputs

Define Project

Prepares for Project

Executes Project

Presents Outcomes

Before Departure

During internship

After Return

http://advances.asee.org/vol02/issue02/05.cfm: Abramson..
Intervening in Student Learning Abroad: A Research-Based Inquiry

• Background work (Michael Vande Berg, Council on International Educational Exchange (CIEE))
  – In study abroad: four-year study; measure the intercultural and second language learning of more than 1,300 U.S. undergraduates enrolled at 61 programs abroad.
  – Central research question—whether U.S. students learn effectively when left to their own devices while abroad, or whether students perform better when educators proactively intervene in their learning

• Key Findings:
  – Most students benefit through enrolling in programs abroad that are intentionally designed to promote their intercultural learning
  – Study also argues that focusing intentionally on learning abroad is especially important for male students (used IDI)
  – Culturally guided development significantly increased inter-cultural learning as measured by the IDI.

• PRIME 2012
  – Conducting weekly interventions with 9 PRIME students in Japan.
  – Hoping to build on “findings” in the future
Components of PRIME 2.0
Cultural Competency

• Preparation for Internship
  – Develop training for students on Asian cultures, histories and economies (site based)
  – Continue to conduct country-specific pre-departure orientation.

• While Overseas
  – Students will connect weekly via Skype with a country-specific cultural learning mentor (i.e., scientist or engineer who is a native of the interns’ host country, trained to engage students in dialogue and reflection about their cross-cultural experiences)

• Upon Return:
  – Students participate in credit-bearing seminar in which they systematically and academically explore and reflect on their progression to global citizenship and what that means – practically and philosophically

Other soft skills to be develop in future
Beyond PRIME 2.0

• Presentation Skills
  – Seminar for Freshmen by PRIME Students

• Develop minor, involving language skill
  – Engage students in freshman year

• Position PRIME within the LEAP framework
  – PRIME as a capstone project

Pre-Experience  
During-Experience  
Post-Experience

Work, Internship  
Or Study Abroad
A Future Institute for Global STEM Education

We are looking for partners

MISSION
create globally minded STEM professionals; prepare them for the workplace of the 21st century

ACKNOWLEDGE
Gabriele Wienhausen
Jim Galvin
Jason Haga

Global-minded 21st Century STEM Professionals

Interdisciplinary Research

Leadership/Professional Skills

Cultural Competency

Educational Innovation

We are looking for partners
Thank You

Congratulations on MURPA 2012-2013
5th Year

Looking forward to seeing some of you in San Diego
Water
The Defining Crisis of the Twenty-First Century

- Daily use per person (England)
  - Drink: 1 to 1.5 gallons
  - Wash, Toilet: 40 gallons
  - Lawns: 100 gallons

- Carbohydrates
  - Pound of rice: 250 to 650 gal
  - Pound of wheat: 130 gal
  - Pound of potatoes: 65 gal

- Meat and meat products
  - Hamburger (meat, ¼ lb): 3000 gal for the feed
  - Quart of milk: 500 to 1,000 gal
  - 1 lb Cheese (cheddar): 650 gal

- Others
  - 1 lb coffee: 2,650 gal

Annual @ Home
50 to 100 tons

Annual @ food, clothes
1500 to 2000 tons
Key Attributes of Network Science

Research Coordination Network
- advance a field or create new directions in research or education
- communicate and coordinate participants research, training and educational activities across disciplinary, organizational, geographic and international boundaries
- foster new collaborations, including international partnerships, and address interdisciplinary topics

Sustainability Research Networks
- support the development and coalescence of entities to advance collaborative research that addresses questions and challenges in sustainability science, engineering, and education
- link scientists, engineers, and educators, at existing institutions, centers, networks, and also develop new research efforts and collaborations.
- significantly crosses and melds the boundaries of diverse disciplines, and creates the integrated science and engineering disciplines of the future

The international, grassroots model offers a unique approach for confronting the challenges of doing networked science across large geographic extents. PC Hanson, Frontiers in Ecology 2007
Asia GEO Grid Initiative
PI: Yoshio Tanaka (AIST)

Objective: To deploy Asia GEO Grid Infrastructure in Asia to share Earth observation data and computing resources for Earth sciences.

1. Catalogue Search
2. Obtain data
3. Process data
4. visualize

Calibration of satellite Data using in-situ data

Global CO₂ Map

AsiaFlux Network

Source: Y Tanaka
DataTurbine Streaming Data Middleware

- Robust real-time streaming data engine for embedded and mobile computing applications
- Stream live data from experiments, labs, web cams and even Java enabled cell phones
- Acts as a "black box" to which applications and devices/sensors/instruments send and receive data
- Scalable – runs on everything from embedded devices to supercomputers
- Open source and freely available – www.dataturbine.org
Other Areas of Learning Needing Increased Emphasis

% saying two- and four-year colleges should place MORE emphasis on helping students develop these skills, qualities, capabilities, knowledge

- Locate/organize/evaluate information: 68%
- Understand global context of situations/decisions: 67%
- Global issues’ implications for future: 65%
- Understand & work with numbers/statistics: 63%
- Understand role of U.S. in the world: 57%
- Knowledge of cultural diversity in US/world: 57%
- Civic knowledge, community engagement: 52%

“Raising the Bar: Employers’ Views on College Learning in the Wake of the Economic Downturn” (AAC&U and Hart Research Assoc. 2010)
As part of its VALUE (Valid Assessment of Learning in Undergraduate Education) project, AAC&U worked with faculty and other academic and student affairs professionals in an exhaustive process of gathering, analyzing, synthesizing, and drafting institutional-level rubrics for 15 of the LEAP Essential Learning Outcomes.

Each VALUE rubric contains the most common and broadly shared criteria or core characteristics considered critical for judging the quality of student work in that outcome area.

The VALUE rubrics reflect faculty expectations for essential learning across the nation regardless of type of institution, mission, size or location.

For more on the VALUE project, please see http://www.aacu.org/value/
LEAP Principles of Excellence

The Principles of Excellence offer both challenging standards and flexible guidance for an era of educational reform and renewal. The Principles of Excellence can be used to guide change in any college, community college, or university. They are intended to influence practice across the disciplines as well as in general education programs.

★ Principle One
Aim High—and Make Excellence Inclusive

★ Principle Two
Give Students a Compass

★ Principle Three
Teach the Arts of Inquiry and Innovation

★ Principle Four
Engage the Big Questions

★ Principle Five
Connect Knowledge with Choices and Action

★ Principle Six
Foster Civic, Intercultural, and Ethical Learning

★ Principle Seven
Assess Students’ Ability to Apply Learning to Complex Problems