Convergence Education

Prior Resources

Handbook of Science and Technology Convergence
W.S. Bainbridge and M. C. Roco, Eds
Springer ISBN 978-3-319-07053-7

Reconceptualization of Education
Chang (et al.)

Acad Res Ctrs: Platforms for Convergence of Science, Technology, and Innovation
Brzakovic (et al.)

Assistive Technology in Education
Quek (et al.)

Convergence Science and Technology at Seoul National University
Pak (et al.)

Cyberlearning
Kolodner

Informal Science Education of Converging Technologies
Bell

Integrative Graduate Education and Research
Hartesveldt

Learning in a World of Convergence
Rundell Singer

Life-Long Learning
McLaughlin (et al.)

Online Courses
Fisher

Precollege Convergence Education
Chang (et al.)

Norms and Standards of Learning
Murday

Materials Science and Engineering

Information Science and Engineering

Nanoscale Science and Engineering
U.S. Education “Continuum”
~$1T/yr Business

Primary
  K-8 mandatory beginning early 1900s

Secondary
  9-12 mandatory beginning early 1920s

Community College/Technical College
  13-14 some states making “free” - prelude to mandatory

Undergraduate
  13-16 Bachelor  5% in 1940  30% in 2013

Graduate
  Masters  7% in 2013

Graduate
  PhD  1% in 2013

Continuing Education (Lifelong)
  Company Internal, University, On-line

Informal Science/Engineering Education
  Museum, media, ...
K-12
Next Generation Science Standards (NGSS)

Crosscutting Concepts
Patterns, Similarity, and Diversity
Cause and Effect
Scale, Proportion and Quantity
Systems and System Models
Energy and Matter
Structure and Function
Stability and Change

Science and Engineering Practices
Science Inquiry
Engineering Design
Build

Disciplinary Core Ideas
Physical Science
Life Science
Earth and Space Science
Engineering, Technology, and Applications of Science

“Convergence”
Global Perspectives in Convergence Education Workshop
NSF / OECD / US National Academies of Sciences / Univ of Southern California
2-3 November 2017
National Academies Building, Constitution Avenue, Washington DC

Agenda

Plenaries

Breakout Sessions
  Teaching Convergence and Responsible Science via the Concept of “Grand Challenges
  Incorporation of Convergence in Curricula in Various Countries
  Mechanism(s) to Keep Abreast of the Workforce Education Needs
  How Best to Coordinate Changes in Educational Institutions with Changes in Funding Agencies
  Science of Team Science and its Role in Convergence Education
  New Technologies for Advancing convergence in Education and Training
  Communication among National Science Funding Agencies to Foster Global Convergence Educ

Discussion of Potential Action Items
Plenary Presentations

- Convergence Science for Societal Progress and Education  
  Mihail Roco, NSF

- Approaches to Convergence Education  
  Susan Singer, Rollins College

- Convergence in Professional Education  
  Michael Richey, Boeing Co

- Integrative Learning  
  Amy Jessen-Marshall, AACU

- OECD Perspective  
  Steffi Friedrichs, OECD

- Convergence Education in Synthetic Biology/Engineering Biology  
  Richard Kitney, Imperial College, UK

- Three Universities, One M.Sc. Program  
  Olof Emanuelsson, RTH SW

- Convergence Education: A Korean Perspective  
  Y. Eugene Pak, SNU, Korea

- Artificial Intelligence and Converging Technologies  
  Eleonore Pauwels, Wilson Ctr, USA
Breakout Sessions

• The Roles of Convergence and Responsible Research in Education  
  Dan Herr,  
  UNC Greensboro  
  Chris Kaiser,  
  MIT

• Six Insights from Developing Digital Educational Tools at MIT  
  Robert Chang,  
  Northwestern

• A Framework for Convergence learning  
  Heidi Schweingruber,  
  U.S. NAS

• Research based Insights for Teaching Convergence Through GC  
  Margaret Hilton,  
  U.S. NAS

• Keeping up with changing Workforce Education Needs  
  Kurt Thoroughman,  
  NSF

• Science of Team Science and its Role in Convergence Education  
  Kara Hall,  
  NCI, NIH

• Science of Learning Program  
  Finbarr Sloane,  
  NSF

• Smart and Connected Communities: Convergence S&E  
  Jin-Taek Kim,  
  Pohang University, Korea

• POSTECH CITE: Creative Convergence Education  
  Fernando Quezada,  
  Biotech Ctr of Excel, Mexico

• Convergence Education Initiatives in Mexico  
  Jorge Huete-Perez,  
  Univ of Central Am, Nicaragua

• Strengthening Research Capacities in Nicaragua
Potential Action Items

K-14

Observation:
Transdisciplinary environments can greatly enhance a student’s educational experience

Action:
Begin building a convergent educational infrastructure by weaving common transdisciplinary platforms and thematic threads through curricula, ultimately a STEA (arts) M ecosystem.

Observation:
A number of grand challenges have been identified that will benefit from convergence in the sciences and engineering.

Action:
Exploit the general public interest in the solution to Grand Challenges by showing, especially at the primary/secondary school levels where the next generation of scientist/engineers is being formed, by developing a convergence education curricula that will better enable those solutions

Observation:
Community Colleges are playing an essential role in the education continuum.

Action Item:
Work towards educating community college / technical college instructors in STEM fields to promote their involvement in Grand Challenge Foci.
Potential Action Items
Post Mandatory Education

Observation:
One of the fastest way for the universities to bring out new knowledge to society goes through the students and their entrance into workplaces.

Action:
A unified program center focused on addressing the challenge of convergence, learning, data analytics and workforce - best practices.

Observation:
Some private industries and some pockets of academia have developed hubs for educating and training researchers on best practices.

Action:
Develop mechanisms for dissemination of best practices; coupling this with funding agencies or other hubs for training could be transformative.
Potential Action Items
International

Observation:
There are wide variants in the different country experiences toward convergence education.

Action:
There would be value in a study of efforts toward convergence around the world, sampling a variety of countries (U.S., Europe, Asia, Central America, Africa), and identifying the roles of the various stakeholders

Observation:
Global Research Council - all the funding agencies around the world meet annually. There are 5 regional meetings, and every year topics are identified for review/study

Action:
Make Convergence Education one of the coming topics.
Potential Action Items
Ecosystem

Observation:
Funding constraints limit the flexibility of Federal initiatives

Action:
Identify programs (such as the SBIR/STTR and EPSCOR programs in the U.S.) that, while not convergence education specific, could be engaged toward meeting convergence education challenges

Observation:
A convergence ecosystem will be necessary to accelerate convergence education

Action:
Identify and publicize prizes and awards that recognize excellence in convergence S&E and encourage the creation of more. (e.g., NASEM Sackler Prize for Convergence Research)

Observation:
There should be a centralized location to share resources about ongoing convergence education efforts

Action:
Use the materials collected for this workshop and its report to initiate a website focused on convergence education
Convergence Education
Prior Resources

Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science
M.C. Roco and W.S. Bainbridge, Eds.

Combining the Social and the Nanotechnology: A Model of Converging Technologies
Gorman
Breath, Depth and Academic Nano-niches
Tolles
Unifying Principles in Complex Systems
Bar-Yam
Mind over Matter in an Era of Convergent Technologies
Akins
Converging Technology and Education for Improving Human Performance
Cohen
Converging Technologies: A K-12 Education Vision
Batterson and Pope
Expanding the Trading Zones for Convergent Technologies
Gorman
Biological Language Modeling: Convergence of Computational Linguistics and Biological Chemistry
Klein-Seethrarman and Reddy

Convergence of Knowledge, Technology and Society,

Implications: People and Physical Infrastructure
Murday (et al)