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 **2016**

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

"Convergence"

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

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
• Six Insights from Developing Digital Educational Tools at MIT	Chris Kaiser, MIT
• A Framework for Convergence learning	Robert Chang, Northwestern
• Research based Insights for Teaching Convergence Through GC	Heidi Schweingruber, U.S. NAS
• Keeping up with changing Workforce Education Needs	Margaret Hilton , U.S. NAS
• Science of Team Science and its Role in Convergence Education	Kara Hall, NCI, NIH
• Science of Learning Program	Kurt Thoroughman, NSF
• Smart and Connected Communities: Convergence S&E	Finbarr Sloane, NSF
• POSTECH CITE: Creative Convergence Education	Jin-Taek Kim, Pohang Univeristy, Korea
• Convergence Education Initiatives in Mexico	Fernando Quezada, Biotech Ctr of Excel, Mexico
• Strengthening Research Capacities in Nicaragua	Jorge Huete-Perez, Univ of Central Am, 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
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Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science
M.C. Roco and W.S. Bainbridge, Eds.
Kluwer Academic Publishers (presently Springer) ISBN 1-4020-1254-3 **2003**

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,
M.C. Roco, W. Bainbridge, B. Tonn, and G. Whitesides, Eds.,
ISBN 978-3-319-02204-8, **2013**

Implications: People and Physical Infrastructure	Murday (et al)