

# Do new fundamentals REQUIRE new pedagogies?

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# Education

Diane Halpern stated in testimony to Congress on the science of learning:

*“The sole reason we have schools and universities, that is formal settings for learning activities, is that we expect that learning will transfer. Information learned in one context can transfer to a different context, but we need to teach in a ways that encourage transfer.*”

In Engineering what changes raise questions or concerns about current pedagogies if we are concerned about transfer?

- Breadth of knowledge
- Depth of knowledge
- Diversity of learners
- Work environments
- Tools available
- Rate of change
- Others?

# What pedagogical changes are promoted as necessary now?

- Teaming
- Active learning
- Problem based
- Design integration and authenticity
- Integrated use of modern tools
- Experiential learning
- Others?

# What are the Fundamentals of Engineering & CS

- NAE said for Engineering Graduate of 2020
  1. will possess strong analytical skills, like engineers of yesterday and today,
  2. will exhibit practical ingenuity
  3. will be creative
  4. will be good communicators
  5. will master the principles of good business and management
  6. will understand the principles of leadership and be able to practice these principles
  7. will have high ethical standards and a strong sense of professionalism
  8. will possess a complex attribute described as dynamism, agility, resilience, and flexibility
  9. will be life long learners.

# What are the Fundamentals of Engineering & CS

- ABET says
  - *(a) an ability to apply knowledge of mathematics, science, and engineering*
  - *(b) an ability to design and conduct experiments, as well as to analyze and interpret data*
  - *(c) an ability to design a system, component, or process to meet desired needs*
  - *(d) an ability to function on multi-disciplinary teams*
  - *(e) an ability to identify, formulate, and solve engineering problems*
  - *(f) an understanding of professional and ethical responsibility*
  - *(g) an ability to communicate effectively*
  - *(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context*
  - *(i) a recognition of the need for, and an ability to engage in life-long learning*
  - *(j) a knowledge of contemporary issues*
  - *(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.*

# What are the Fundamentals of Engineering & CS

- Design/Creation (3)
  - Setting for design (4)(d, g)
  - Reason/context/meaning of design (5, 7) (f, h, j)
  - Process for design (c)
    - What is already available
    - What are the constraints
    - What is known (j)
    - What is needed (2,6) (e)
    - Assessment/Iteration (1) (a, b, k)
- Staying change ready (6, 8, 9) (i)

# Well crafted research experiences, strengthen the development and assessment of these

- Design/Creation
  - Setting for design
  - Reason/context/meaning of design
  - Process for design
    - What is already available
    - What are the constraints
    - What is known
    - What is needed
    - Assessment/Iteration
- Staying change ready
- Good Research
  - Knows the state of the current knowledge
    - What's known
    - What's unknown
  - Can decide what we need to know next
  - Can Design Experiment to find out
  - Can share what is learned

Doesn't the tight interaction between research design change readiness, make research a fundamental?

Modern engineers/CS professionals must

- Be able to use research discoveries
- Know when research is needed
- Know the difference between research and design

# Pedagogical Tactic for A Required Fundamental

- It appears that undergraduate research would be one of the more efficient approaches to demonstrating that students
  - *(a) an ability to apply knowledge of mathematics, science, and engineering*
  - *(b) an ability to design and conduct experiments, as well as to analyze and interpret data*
  - *(e) an ability to identify, formulate, and solve engineering problems*
  - *(g) an ability to communicate effectively*
  - *(i) a recognition of the need for, and an ability to engage in life-long learning*
  - *(j) a knowledge of contemporary issues*
- Engineering faculty should craft these endeavors around the fundamental acquisition for all graduates, not the recruitment of a subset of graduates into graduate school.

# Exercise

- Map research experience to ABET outcomes
- Describe requirements of your research experience for this mapping
- Describe assessments of your research experience
- Place your experience in a curriculum