# NCN Education and Assessment Workshop

# Integrating Computational Simulations into Learning Environments

November 5-6, 2009
Big 10 Conference Center

**Welcome!** In our short time together we will explore issues and opportunities for designing effective learning environments in nanoscale science and engineering using nanoHUB.org resources. The presenters at this workshop have experience designing instructional materials and methods based on principles associated with the How People Learn (HPL) Framework reported in a National Academy Report called How People Learn: Mind, Brain, School and experience. This framework provides us with a structure and shared vocabulary for thinking about the critical features that exist in *effective* learning environments. At the end of the course you should have a working knowledge to apply the HPL framework to evaluate and design effective learning environments. In addition, you should be leaving with a clearly defined set of objectives for your course, a plan for how to assess these objectives and an outline for instruction methods you will use with nanoHUB resources to support students learning.

## Objectives for the workshop

Articulate clear plan for learning outcomes and measurement of outcomes
Increase awareness of how to use nanoHUB simulations to increase student learning.
Increase awareness of current nanoHUB resources and how best to integrate these into a course(s)
Extended participants network of other instructors who are integrating nanoHUB resources into their courses

## Agenda

Overview of the Instructional Design Process
Identifying Learning Objectives
Learning more about others uses
Identifying learning objectives
Review resources and learning materials on nanoHUB
Working session to generate

# Detailed Agenda

| **Time** | **Activity** |
|---|---|
| Day 1 – November 5, 2009 | |
| 1pm – 5pm | Attendees Arrive |
| 5:30 – 6:15pm | Registration |
| 6:15 – 6:30pm | Find places, setup laptops, check wireless etc. |
| 6:30 – 7:30pm<br>**Ice Breaker** | [1] Introductions from each participant including their current or planned uses of nanoHUB resources in their courses and/or curriculum.<br>[2] Share amusing anecdotes about things that did and did not work as planned in past courses involving (nanoHUB or other) simulations?<br>[3] Overview of Workshop |
| 7:30pm – Open<br>***Networking*** | Group Dinner |
| Day 2 – November 6, 2009 | |
| 8:00 – 8:30am | Breakfast |
| 8:30-8:45 ***Welcome/Overview: Backwards Design for Instruction*** | |
| 8:30 – 9:15am<br>***Learning Objectives*** | [1] Participants share how they use or plan to use nanoHUB resources in their course(s) in small groups.<br>[2] Each participant creates a list of the learning objectives related to nanoHUB for their course(s). |
| 9:15-10:00am<br>***Peer Case Studies*** | [1] Short presentations by current users of nanoHUB for learning<br>[2] Group discussion |
| 10:00 – 10:30am<br>***How People Learn: Theory & Practice*** | Introduce participants to the "How people learn" framework. Challenge them to identify which parts of this framework apply in their institutional learning context. |
| 10:30 – 10:45am | Break |
| 10:45 – 11:15am<br>***Evidence of Learning*** | Interactive session with presentations and discussion. |
| 11:15 – 11:45am<br>***Refine Learning Objectives*** | Working in pairs or small groups with related interests, refine learning objectives and briefly consider effective learning activities and related assessment activities. |
| 11:45 – 12:30pm<br>***Exchanging nanoHUB resources*** | Hands-on session about access to learning resources in nanoHUB and ways to contribute additional resources. |
| 12:30-1:00pm | Lunch |
| 1:00-2:30pm<br>***Design Your Learning Activities and Assessments*** | [a] Brief report back and refine approach;<br>[b] Work in pairs or small groups to develop appropriate learning activities and assessment methods to match student learning objectives;<br>[c] Develop a basic implementation plan. |
| 2:30 – 3:00pm<br>***Share & Compare*** | Participants present and hear critique/discussions with other groups |
| 3:00-3:15pm | Break |
| 3:15 – 4:30pm<br>***Implementation Plan*** | Participants refine implementation plan including how their new/refined course(s) or curriculum will be evaluated. |

## ACTIVITY:

## Challenge: Raising the Bar

Challenge
and
Initial Thoughts

**ACTIVITY** – Here is a challenge faced by a colleague of yours. Please take a moment to read the challenge, then generate several initial thoughts and questions about his situation.

**Challenge:** Jack has been teaching and refining an introductory course on signal processing for many years. His goal for the course is for students to be able to analyze the limits of a given signal processing approach and design their own processing model for a specific application. He uses a great textbook that provides an excellent review of basic circuits and covered the fundamental topics associated with measuring and analyzing low level voltage and current signals. He finds that many of the students needed a refresher on basic circuits, so he conducts review lectures during the first two weeks of the course. He thinks this is a good introduction to ease students into the semester. Jack asks his students to prepare for class by reading sections in the book relevant the major topics he covers in class. When possible he likes to begins his lecture with a demonstration or animation to highlight key points he plans to make during class. This usually is a big hit with the students expressing their OOs and AHs. He enjoys the demonstration because it often leads to students asking questions which set up his lecture perfectly.

After class students are required to apply the principles they just learned by answering questions in the back of the book along with a special problem he constructs that targets the key points of his lecture. Students typically perform well on these homework assignments and Jack assumes they were ready for his exams. On average the students perform fairly well and the distribution of grades were normal. However, upon closer investigation he notices that students tend to make most of their points on the shorter problems similar to the ones in the book. His more open ended “special” problems results in a skewed distribution of performance. Jack is concerned that students may not be as prepared for analyzing, trouble shooting and designing instrumentation and would like to refine his course to improve students’ ability to answer all the questions with higher proficiency.

**<u>Generate Initial Thoughts</u>**

1. What does Jack do that works well?

## Generate Initial Thoughts (cont.)

2. What suggestions would you make to Jack to help him improve his course?

3. What more would you like to know about Jack's course and his teaching method?


## ACTIVITY 3:

## Reflections on Presentations

**Instructions**: The following presentations may lead to new insights. Listen to the presentation for critical points that are relevant to your goals and desired outcomes during your course. Take a moment to jot them down either during the presentation or during the short interlude between presentations.

**Presentation 1 – Overview of the HPL Framework - Key Points**

**Presentation 2 – Nanotechnology example 1 - Key Points**

**Perspectives,**
**Ideas and Resources**

**ACTIVITY:**

**Reflection on Raising the Bar Challenge**

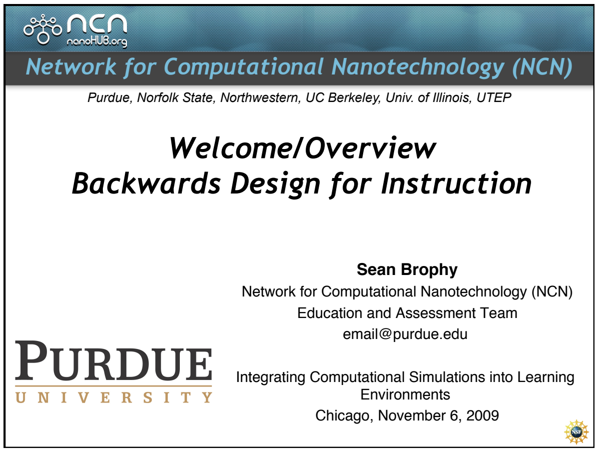
**Instructions: How could Jack refine his instruction using the HPL Framework to inform his practice?** Back in Activity 2 you were asked to generate your initial thoughts about Jack's situations. Take a moment to look back at your initial thoughts you generated. Do you have any new insights to add? Or would you like to refine any initial thoughts?

**Refine Initial Thoughts**

1. What does Jack do that works well?

2. What suggestions would you make to Jack to help him improve his course?

3. What more would you like to know about Jack's course and his teaching method?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Network for Computational Nanotechnology (NCN)
Purdue, Norfolk State, Northwestern, UC Berkeley, Univ. of Illinois, UTEP
Welcome/Overview
Backwards Design for Instruction
Sean Brophy
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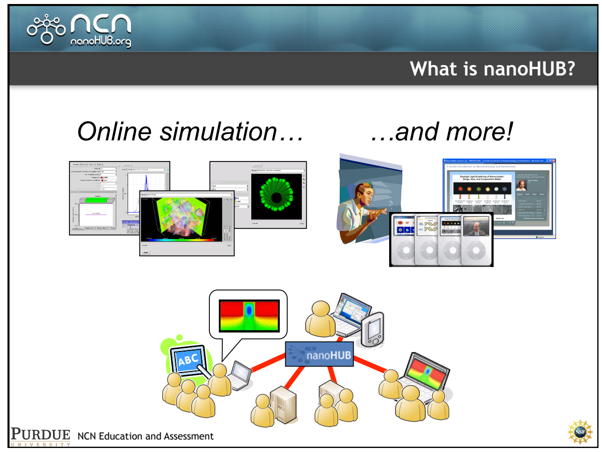
Integrating Computational Simulations into Learning Environments
Chicago, November 6, 2009


nanoHUB.org
What is nanoHUB?
Online simulation…
…and more!
ABC
nanoHUB
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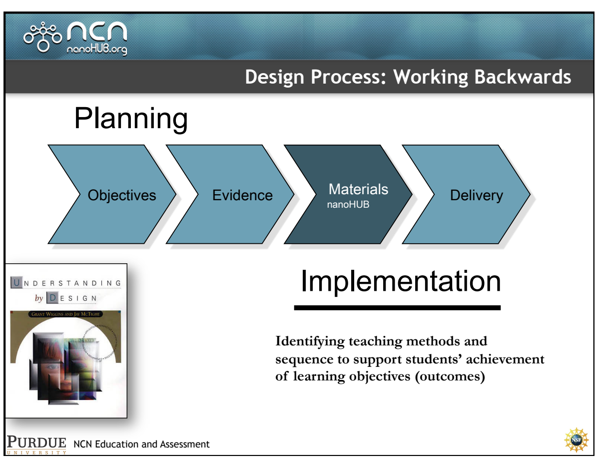
nanoHUB.org
Design Process: Working Backwards
Planning
Objectives
Evidence
Materials
nanoHUB
Delivery
UNDERSTANDING by DESIGN
Implementation
Identifying teaching methods and sequence to support students' achievement of learning objectives (outcomes)
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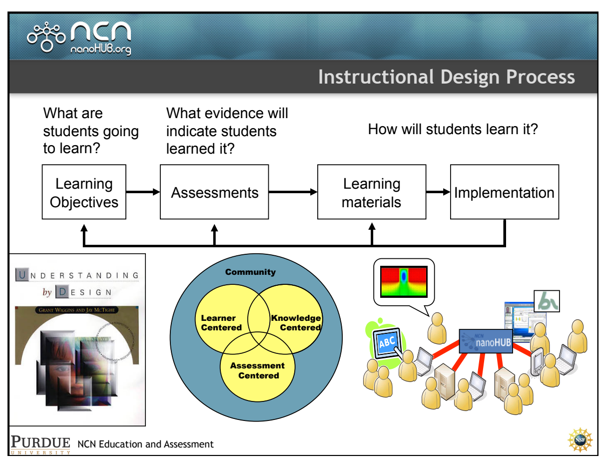
nanoHUB.org
Instructional Design Process
What are students going to learn?
What evidence will indicate students learned it?
How will students learn it?
Learning Objectives
Assessments
Learning materials
Implementation
UNDERSTANDING by DESIGN
Community
Learner Centered
Knowledge Centered
Assessment Centered
ABC
nanoHUB
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## Overview for the Day

- Objectives for the workshop
  - »Identify objectives and indicators of learning
  - »Connect with other instructors using nanoHUB
  - »Increase awareness of…
    - ✓ current nanoHub resources
    - ✓ how student learn with simulations
    - ✓ instructional methods to support learning
  - »Generate new ideas for your course



## Overview for the Day

- Plan for the day
  - »Overview of the Instructional Design Process
  - »Identifying Learning Objectives
  - »Learning more about others uses
  - »Identifying learning objectives
  - »Review resources and learning materials on nanoHUB
  - »Working session to generate

## The Cognitive Process Dimension

**The Knowledge Dimension**

| | Remember | Understand | Apply | Analyze | Evaluate | Create |
|---|---|---|---|---|---|---|
| **Factual Knowledge** – The basic elements that students must know to be acquainted with a discipline or solve problems in it.<br>a. Knowledge of terminology<br>b. Knowledge of specific details and elements | Recall | Restate | Employ | Distinguish | Select | Arrange |
| **Conceptual Knowledge** – The interrelationships among the basic elements within a larger structure that enable them to function together.<br>a. Knowledge of classifications and categories<br>b. Knowledge of principles and generalizations<br>c. Knowledge of theories, models, and structures | Define | Describe | Translate | Compare | Defend | Combine |
| **Procedural Knowledge** – How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.<br>a. Knowledge of subject-specific skills and algorithms<br>b. Knowledge of subject-specific techniques and methods<br>c. Knowledge of criteria for determining when to use appropriate procedures | Relate | Identify | Demonstrate | Contrast | Interpret | Construct |
| **Metacognitive Knowledge** – Knowledge of cognition in general as well as awareness and knowledge of one's own cognition.<br>a. Strategic knowledge<br>b. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge<br>c. Self-knowledge | Review | Express | Examine | Deduce | Discriminate | Propose |

Imbrie and Brophy, 2007

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## Network for Computational Nanotechnology (NCN)

Purdue, Norfolk State, Northwestern, UC Berkeley, Univ. of Illinois, UTEP

# Thinking about Learning Objectives

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## Design Process: Working Backwards

Objectives → Evidence → Materials (nanoHUB) → Delivery

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## Learning Objectives – Example from ENGR 195 (at Purdue)

- Most engineering students need to understand how to use computational tools
- To this end, they need to know some programming
- Flowcharts allow students to understand programming flow/logic
- Also helps them understand the role of standard representations



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## Learning Objectives – Example from ENGR 195 (at Purdue)

- At the end of this class/session, you will be able to….
  - »**Use** Flowcharting as a tool to support your design process
    - ✓**Identify** specific shapes used in flowcharts
    - ✓**Distinguish** between the function of the various shapes
  - »**Apply** conditional statements and loops/iterations as part of your flowchart generation process

**Use** **Identify** **Distinguish** **Apply**



### The Cognitive Process Dimension

The Knowledge Dimension

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| **Metacognitive Knowledge** – Knowledge of cognition in general as well as awareness and knowledge of one's own cognition. a. Strategic knowledge b. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge c. Self-knowledge | Review | Express | Examine | Deduce | Discriminate | **Use** |

Imbrie and Brophy, 2007

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## Writing Learning Objectives

- Begin with the **big concepts** that you want students to know
- Identify the **sub-concepts/pre-requisites** that are needed
- Use **specific action words** from Revised Bloom's Model
- Think about how you would **measure** these objectives

## Activity (20 – 25 minutes)

- In small groups or in pairs:
  - » List two or three big concepts that you want students in your class to learn
  - » Identify sub-concepts that are associated with one or two of the big concepts
  - » Attempt to write some specific learning objectives for your course content
  - » Use the Revised Bloom's Model to guide you
  - » Go to the nanoHUB and find materials to use readily

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# How People Learn: Theory and Practice

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## Providing a framework for Designing Instruction

- Driving questions for this session
  - » What is the range of potential learning objectives?
  - » What is the interaction between learning objectives?
  - » What makes an effective learning environment?
  - » What factors influence student learning?
  - » What opportunities exist for my students?



## Possible Learning Objectives with Simulations and Models

- How do computational scientists and engineers use simulations and models to support their inquiry?
- Using simulations to support inquiry
  - » **Design** experiments to answer driving questions
  - » Generate data to **explain** behavior of a phenomenon
  - » Compare and contrast system states to **explain** governing principles
  - » **Analyze** design decision of a nanoscale device
- Building computational models to support inquiry
  - » Apply computational/numerical techniques
  - » Validate models relative to empirical data
  - » Identify and explain limits of a particular model
  - » Adapt models to increase accuracy and precision



## CASE 1 - Striking a Chord

What are his learning goals?
How is he achieving these goals?

Source: Mr. Holland's Opus

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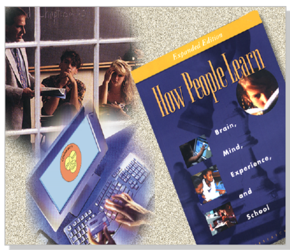
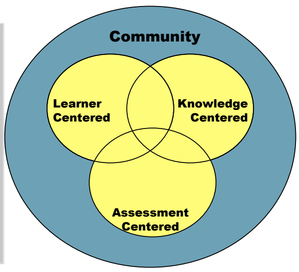
## How People Learn: Brain, Mind, Experiences and School

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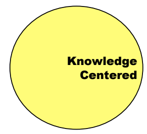
## Defining Necessary Knowledge




- Targeted goals for learning
  - »Fundamentals
    - ✓Principle concepts
    - ✓Skills and facts
  - »Important concepts
  - »Familiarization with related concepts
- Organized to facilitate acquisition and application

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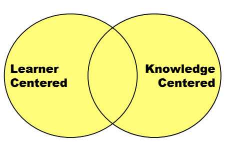
## Identifying Learners Needs




- Learner Centered
  - Lack of prior knowledge
    - Domain concepts
    - Conditions of applicability
  - Preconceptions
  - Hard to comprehend concepts
  - Developing mastery (e.g. mathematics)
  - Developing identity

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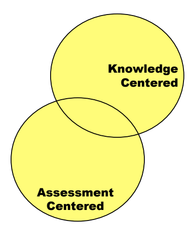
## Assessing Knowledge




- Summative Assessments
  - End of Unit
  - Test of Mastery
  - Sequestered problems solving

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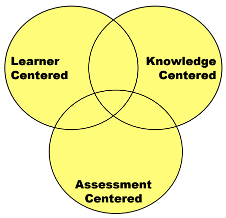
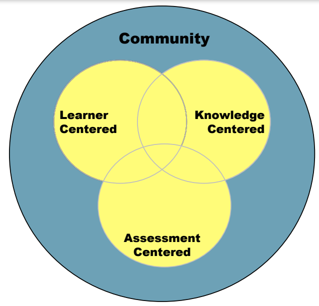
## Assessment Centered: Track Development




- Formative Assessment
  - Continuous opportunities to demonstrate what students know
  - Student reflection
  - Develop metacognitive skills
  - Facilitates continuous improvement of instruction
    - e.g. Personal Response System



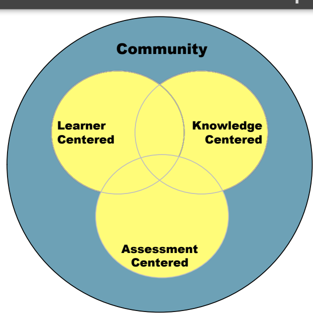
## Community Centered




- Connections with instructor, peers and professional community
  - »Classroom + department
  - »Understanding perspectives – e.g.
    - ✓Approach to problems
    - ✓Prioritizing design factors
  - »Developing identity
    - ✓Student
    - ✓Professional



## How People Learn (HPL) Framework




HPL Framework provides guidelines for identifying critical factors associated with effective *learning environments*.



## Activity 2 Challenge – Raising the bar

Challenge and Initial Thoughts

- Read through the challenge in your packet
- Generate your initial thoughts
  - »What does Jack do that works well?
  - »What suggestions would you make to Jack to help him improve his course?
  - »What more would you like to know about Jack's course and his teaching method?