



**Evaluation & Assessment:
What's the Difference;
Why Does E & A Matter
in the NCLT?**




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Today's Topics

- A "Primer" about terms:
 - Differences & connections
 - Applications to NCLT
- Making it real:
 - Examples of evaluation designs & assessment data supporting the work of the NCLT
- The NCLT Evaluation Plan
 - Goals, work circles, products, and criteria
- A small group exercise in articulating evaluation plans

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A Distinction with a Difference

- **Evaluation** is the systematic determination of merit, worth, and significance of something or someone. It is an informed act of ascertaining or fixing the value or worth of a given project or product.
- **Assessment** is the process of documenting, usually in measurable terms, knowledge, skills, attitudes and beliefs.
- Well designed **Assessments** can help serve the purposes of an appropriate **Evaluation** plan/model
 - Assessing something is not the same as evaluating it

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A Bit More About Assessment

- Assessments can be classified in many different ways. The most important distinctions are:
 - formative and summative;
 - objective and subjective;
 - referencing (criterion-referenced, norm-referenced);
 - informal and formal
- Much more to come on assessment tomorrow
 - Assessment as a “process of reasoning from evidence”
 - Designing assessments of conceptual knowledge using a process called Evidence Centered Design

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Critical Role of Evaluation & Assessment in the NCLT

- An integrated E & A effort
 - Responds to the need for internally & externally acceptable indices of progress and accomplishment
 - Demonstrates efficacy of the NCLT’s implementation of instructional design/development principles based on knowledge in the learning sciences and nanoscience
 - Demonstrates impact of the NCLT’s integrated activities and the Center more broadly on multiple constituencies spanning K-20+
- Opportunity
 - If the NCLT is planful & systematic in E & A it can show how the rhetoric in the proposal has been made to work in practice

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Evaluation: Two Examples

- 1) Pedagogical Change in a NanoMaterials Course
 - Impact of change on
 - Student performance (understanding of nanoscience)
 - Experience of the pedagogical changes
- 2) Faculty Development Workshop
 - enhance participants’ knowledge of nanoscience.
 - develop nanoscience courses and units
 - developing learning objectives, pedagogical approaches and assessment techniques
 - develop a community of faculty involved in teaching nanoscience

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Example 1
Pedagogical Innovation/Change

Nanomaterials Course
(Mark Hersam: seniors & grad students)

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Evaluation Design

2001: Historical Control (n=17)

- traditional Lectures - interaction encouraged
- Individual Project – literature review

2002: Pedagogical Change: (n=16)

- Collaborative learning
- Problem-based learning
- Peer assessment
- Interdisciplinary learning

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Evaluation Design

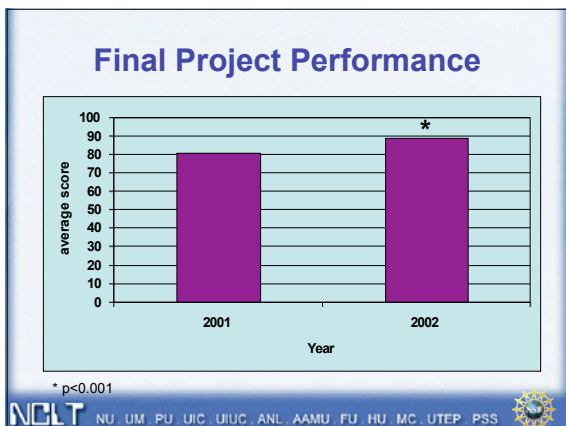
Pedagogical Change (as a whole)

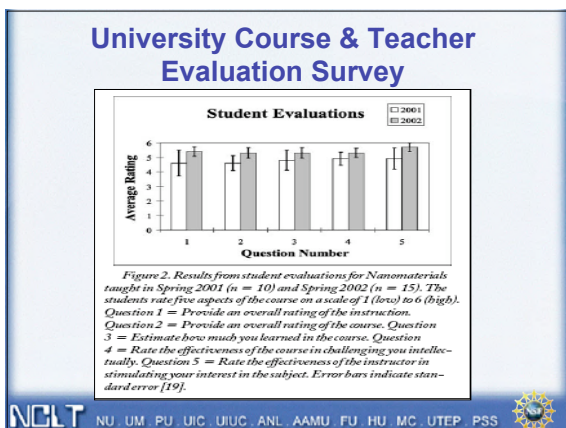
- Student Performance: Understanding of Nano Concepts
 - The instrument used was the final project: remained the same (Instructor portion)
- Student Experience
 - University course & teacher evaluation survey

Pedagogical Change (individual activities)

- Student Experience
 - Nominal group process (qualitative)

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- ### Nominal Groups Process
- **Interdisciplinary exposure extended knowledge base and improved learning.**
 - “Through group work, we have been exposed to different disciplines and backgrounds. This has really helped us learn.”
 - **Collaborative Projects improved learning**
 - “Through group work, we have been exposed to different disciplines and backgrounds. This has really helped us learn.”
 - **Peer projects/assessment can help improve interpersonal skills**
 - “I have learned a lot about working with my peers and doing group presentations. I think these are valuable skills.”
 - **Problem-based assignments contributed to relevance of course & interest on further personal learning.**
 - “I have been exposed to things that I never knew were possible or existed. The wide exposure to so many concepts is highly beneficial and opens the road for further personal investigation”
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Example 2
Faculty Development Workshop

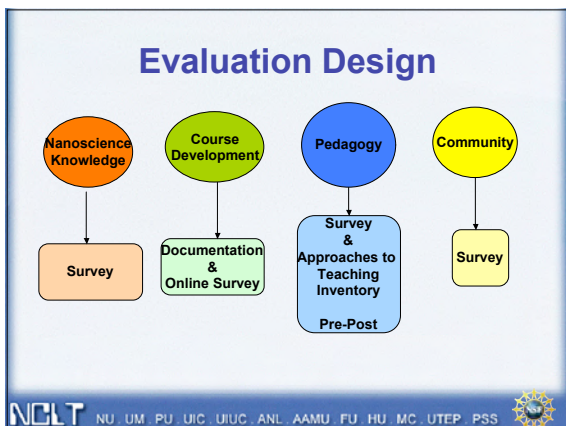
Learning and Teaching in
Nanoscale Science and
Engineering

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Workshop Goals

1. To identify big ideas in nanoscience at the higher education level.
2. To enhance participants' knowledge of nanoscience.
3. To partner with participants to develop nanoscience courses and units.
4. To provide frameworks to assist participants in developing learning objectives, pedagogical approaches and assessment techniques.
5. To develop a community of faculty involved in teaching nanoscience.


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Nanoscience Knowledge


- Did the workshop increase your knowledge of nanoscience/nanotechnology ?

Yes (18) No (2) NR (2)
- If yes, please describe what you learned?

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Nanoscience Knowledge Themes

- Change in priority of forces depending on size
- Integration of engineering nanoconcepts with the biological sciences
- Understanding of how other disciplines view nanoscale science
- Limitations based on size effects of field effect transistor
- Perspective on social and ethical implications of nanotechnology
- Breadth of nanoscience/nanotechnology

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Course Development

- Presentation of action plans
 - Title
 - Course context
 - Learning Objectives
 - Assessment Techniques

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Approaches to Teaching Inventory

- 16 item inventory
- 5 point Likert Scale
- 2 Subscales:
 - Conceptual Change (CC)
 - Information Transmission (IT)

- I design my teaching in this subject/course with the assumption that most of the students have very little useful knowledge of the topics to be covered (IT).
- I make available opportunities for students in this subject/course to discuss their changing understanding of the subject. (CC)

Prosser & Trigwell 1999

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Pedagogy

	Agree strongly	Agree	Disagree	Disagree Strongly
Identified challenges in teaching nano	12	10	0	0
Developed strategies for overcoming challenges	3	19	0	0
Framework for developing learning objectives	11	11	0	0
Framework assessing learning	4	16	2	0

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Community

	Agree strongly	Agree	Disagree	Disagree strongly
I developed new professional relationships.	16	6		0

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Center Goals & Activities as “Drivers” of the E & A Process

1. Develop fundamental research about prior knowledge, learning trajectories, and learning experiences to support students in learning the challenging subject matter of NSE.
2. Develop fundamental knowledge and models of how to prepare 7-16 instructors in teaching NSE and using NSE materials.
3. Develop courses & programs (grades 13-16) to serve as models to other universities & colleges.
4. Develop a cadre of individuals who can pursue research on the teaching and learning of NSE.
5. Develop 7-16 Teachers/Instructors in NSE sensitive to the learning and teaching of NSE and understanding NSE.
6. Through research and leadership capacity building, impact minority institutions & at-risk populations in understanding and teaching of NSE throughout the US.
7. Establish NCLT as a national leader, building an NSE clearinghouse of information in NSE & NSEE.

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Mapping of Work Units to Goals

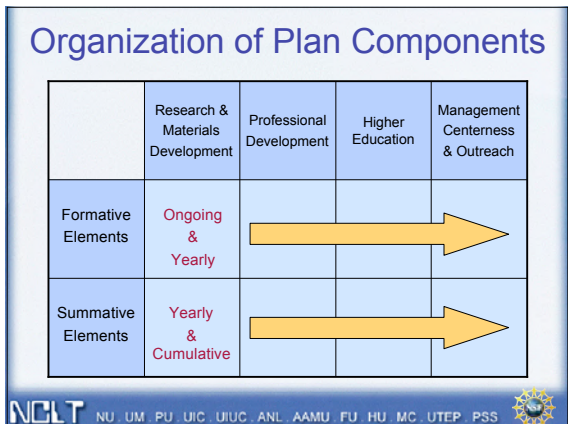
- **Research & Development:** Krajcik et al.
 - Goals 1 & 2: research agenda for 7-16 schooling
- **Higher Education:** Mason et al.
 - Goals 3, 4 & 5: leadership capacity, courses & degree programs
- **Professional Development:** Giordano et al.
 - Goals 3, 4 & 5: models for PD programs in NSE
- **Outreach, Impact & National Leadership:** Chang et al.
 - Goals 6 & 7: outreach, minority partnerships, national clearinghouse

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Components of the Evaluation Plan

- **Formative** --> monitor & improve ongoing activities & update yearly plans
 - largely an internal effort
- **Summative** --> collect evidence of cumulative accomplishment
 - external team led by Andy Porter

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Evaluating the Evaluation Plans

- Organize yourselves by “Primary Work Circles”
- Review the Evaluation Plan applicable to your group -- 20-25 minutes
 - What are its strengths?
 - What are its weaknesses?
 - Elaborate the plan as needed -- add specifics, examples, missing elements, critical information
- What will it take to realize the plan?
 - Persons, time, data collection processes, assessments
- Be prepared to report back: 2 mins per group
 - Major issues and recommendations
 - Keep a written summary of all your recommendations

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Unit 1: Research & Development on the Teaching and Learning of NSE Concepts

- NCLT is actively pursuing a research agenda on the teaching and learning of NSE concepts; the principal objective is to gain knowledge that will inform the field through publications in the science education, educational policy, and teacher education literatures. Our research includes the development of the learning activities and the technology tools by making use of our research findings to inform the educators how to embed the nanoscience concepts into existing curriculum.
- Relevant Work circles:
 - Nanoscience Student Learning and Motivation (Nano SLAM)
 - Learning Progressions: Particle Model, and Size and Scale
 - Self-Assembly
 - Nano-concept Inventory

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Unit 1 Evaluation

Typical Deliverables: The Center's accomplishments in this area will be monitored through scholarly products of: (a) periodic white papers and reports, (b) paper and poster presentations at regional and national meetings, and (c) journal articles and chapters published in respected outlets.

Evaluation Foci: The evaluation efforts will focus on the following sources of quantitative and qualitative evidence of the accomplishment:

- Timely completion of the planned R&D projects and reports
- Cumulative number of the reports and publications
- Indicators of the importance and quality of the research described in individual reports
- Indicators of the coherence of a program of study over time and across multiple publications
- Indication of the impact of our research efforts on 6-12 STEM education
- Field testing the effectiveness of activities (tools) on student learning in nanoscience

Evaluation Criteria & Methods: The evaluation criteria for our research and development will include the following:

- Quantity of journal publications, book chapters, conference papers, technical reports, conference presentations and posters
- Impact of our research findings on 6-12 STEM education as measured by the number of occasions that the findings are incorporated externally (e.g. influence on national, state and local standards; invitations to give workshops; participation in panel discussions; invited presentations, etc.)
- Changes in learning gains and/or students' motivation as result of implementation of our research activities as measured by various instruments.

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**Unit 2: Grades 7-12
Teacher Professional Development**

- Over the life of the Center, NCLT expects to recruit, train, and develop (pre-service and in-service) 7-12 teachers who will be prepared to lead nanoscience curriculum adoption in their schools and promote the inclusion of NSE in the science education curriculum at professional, regional and national meetings.
- **Relevant Work circles:**
 - Professional Development

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Unit 2 Evaluation

Typical Deliverables: The Center's accomplishments in this area will be monitored through production of: (a) periodic reports of professional development workshops and related activities; (b) shareable PD program designs and materials; (c) evaluation reports based on data collected specifically to determine efficacy and impact of the professional development activities on teacher practice; (d) paper and poster presentations at regional and national meetings, and (e) journal articles and chapters published in respected outlets. These goals will be achieved in part by the application of research results from the work circles in Units 1 and 5. The PD research will also inform those work circles.

Evaluation Foci: The evaluation efforts will focus on the following sources of quantitative and qualitative evidence of accomplishment:

- Indicators of recruitment of a diverse group of teachers with leadership potential and Center support for positioning them to introduce and nurture change.
- Indicators of delivery of PD programs which include the structural features of effective professional development.
- Indicators of program content and activities that: (i) focus on deepening teachers' knowledge of nano content, (ii) offer teachers a well-designed activities of science concepts and lab experiences, (iii) are coherent and integrated, and (iv) change teacher's practices and generate improvements in student achievement.
- Indicators of teacher participation and engagement that includes collaboration, development of an interdisciplinary perspective, and cross-disciplinary communications skills.

Evaluation Criteria & Methods: The table below lists the measurable goals of the PD and the methods used to evaluate the effectiveness of the PD in achieving these goals. These evaluations will be conducted in conjunction with our summer PD workshops, with follow-up workshops and through data gathered from the participants' classrooms.

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Measurable	Evaluation method
Teachers' attitudes and perceptions.	• Pre- and post-surveys. • F o c u s g r o u p i n t e r v i e w s .
Teachers' pedagogical knowledge: Conceptions of teaching through inquiry, Conceptions of the use of models in nanoscience.	• Pre- and post-surveys. • T e a c h e r s ' w r i t t e n d o c u m e n t s f r o m w o r k s h o p . • L e s s o n p l a n i m p l e m e n t a t i o n a n a l y s i s p r o t o c o l (f r o m t e a c h e r s) . • C l a s s r o o m o b s e r v a t i o n s .
Teacher nanoscience content knowledge .	• Pre- and post-tests (topic specific). • S c i e n c e n o t e b o o k s (l a b r e p o r t s) . • C l a s s r o o m o b s e r v a t i o n s . • T e a c h e r i n t e r v i e w s . • C o n c e p t i n v e n t o r y .
Student nanoscience content knowledge .	• L e s s o n p l a n i m p l e m e n t a t i o n a n a l y s i s p r o t o c o l (f r o m t e a c h e r s) . • S c i e n c e n o t e b o o k s (l a b r e p o r t s) . • Pre- and post-tests (topic specific). • C o n c e p t i n v e n t o r y . • S t u d e n t i n t e r v i e w s . • C l a s s r o o m o b s e r v a t i o n s .
Alignment with state and national standards.	• W o r k s h o p m a t e r i a l s . • T e a c h e r s ' l e s s o n p l a n s . • L e s s o n p l a n i m p l e m e n t a t i o n a n a l y s i s p r o t o c o l (f r o m t e a c h e r s) .

Unit 3: Higher Education -- Developing Leadership Capacity & Implementing Degree Programs

- The Center's overarching objective in the Higher Education area is the establishment of a community of learners-teachers among college and university faculty nationwide who are capable of providing leadership in NSE education. This community includes existing university faculty as well as prospective faculty, i.e., individuals who are currently pursuing a Ph.D. or who are in post-doctoral training.
- Relevant Work circles:
 - Higher Education
 - Degree Programs (HE subgroup)
 - Undergraduate Course Development (HE subgroup)
 - Community of Learners

Unit 3 Evaluation


Typical Deliverables: The Center's accomplishments in this area will be monitored through reports describing the: (1) design and delivery of faculty enhancement workshops that promote inclusion of nano-content and appropriate pedagogy in undergraduate courses, (2) undergraduate and graduate degree programs developed on NCLT and affiliated campuses, (3) development of resources (courses, nano-units, laboratories, demos, etc.) for higher education, and (4) programs and activities developed for graduate students and post docs that offer multidisciplinary research training experiences.

Evaluation Foci: The evaluation efforts will focus on the following sources of quantitative and qualitative evidence of accomplishment:

- Indicators of diverse attendees at faculty workshops and related activities
- Evaluation data collected specifically to determine efficacy and impact of the faculty workshops on faculty practice
- Indicators of Higher Education program development and implementation
- Indicators of resource development for higher education on the NCLT web portal (nano-courses, nano-units, laboratories, demos, etc.)
- Indicators of participation by graduate students and post docs in Center organized training programs
- Indicators of participation by graduate students and post docs in Center-based multidisciplinary research and development efforts


Unit 3 Evaluation

Evaluation Criteria & Methods: Higher Education efforts will be evaluated by: (1) survey instruments regularly employed at faculty workshops, (2) on-line evaluation instruments employed for nano-course and nano-unit implementations in the classroom, (3) the growth in postings of Degree Programs captured on the NanoEd Resource Portal, (4) the growth in postings of Higher Education resources (nano-courses, nano-units, lectures, laboratories, demos, etc.) on the NanoEd Resource Portal, (5) regular reports on graduate student and post doc participation in Center organized training (Community of Learners), (6) regular reports on graduate student participation in Center-based multidisciplinary research and development efforts, including degree completion data.

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Unit 4: External Relations & Networking

- The NCLT is designed to be part of a larger intellectual community that includes other nano centers funded by NSF as well as a diverse set of institutions who are engaged in nano research and education. One major goal is to serve and work with other national groups and promote the enhancement of a community dedicated to advancing NSE and NSEE.
- Relevant Work circles:
 - All


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Unit 4 Evaluation

Typical Deliverables: The Center's accomplishments in this area will be monitored through the production of documents and other information sources that indicate the nature of the relationships established and interactions that have occurred with various constituent groups, plus the near-term and long-term results that have accrued. The "products" may be reports, workshop proceedings, meeting notes, interviews and other forms of evidence.

Evaluation Foci: The evaluation efforts will focus on the following sources of quantitative and qualitative evidence of accomplishment:

- Indicators that the Center is actively building partnerships and collaborations to further its mission and build an NSEE community.
- Indicators that the Center interacts productively with other centers and programs related to NSEE such as NSF-funded Centers, research institutes, technical societies, etc.,
- Indicators that the Center's partnerships and collaborations are supporting the integration of NSE into 7-16 Grade STEM curricula.
- Indicators that the Center is producing research collaborations across disciplines
- Indicators that the Center is helping to bridge gaps across disciplines

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Unit 4 Evaluation

Evaluation Criteria & Methods: The team strategically works to research and evaluate the NCLT relationships and collaborations to reach appreciable outcomes that will build capacity in NSEE. Sustainable projects and collaborations with broad impacts is the target for each of these external relationships, as well as the diversity of disciplines these relationships encompass. Internal documentation on numbers and types of audience reached as well as usage tracking statistics of materials on the NanoEd Resource Portal authenticates the quality and effectiveness of these external relationships and networks. (Note: 20% of the contributions uploaded onto the NanoEd Resource Portal have resulted from external networking.)

- Content quality is maintained through peer review, advisor review and quality review from NCLT staff with appropriate expertise and experience. Review Guidelines focus upon the following criteria:
 - Relationship to the Nanoscale
 - Scientific Accuracy
 - Aligns with correct categories, keywords, etc.
 - Focus aligns with mission & goals
 - Usability, appropriate for the attributed audience
- The success of our relationships is realized through broader impact, where our external relationship further impacts other relationships and grows the reach of the NSEE community. This team is working to provide quantitative documentation as well as qualitative analysis. Interviews and endorsement letters will be obtained to document these external relationships' impacts on NSE in the classroom.

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Unit 5: Nanoconcepts Research and Development

- NCLT is working with a team of nanoscience researchers and education specialists, to link cutting-edge research to nanoconcepts that can be incorporated into the classroom. The focus of our nanconcepts research and development is to link the macro-world to the nano-world by learning and teaching through inquiry and design of nanoscale materials and applications. Development of simulations and online resource tools will help augment this effort.
- **Relevant Work circles:**
 - Nanomaterials
 - Manipulation of Light
 - Information Storage

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Unit 5 Evaluation

Typical Deliverables: Evidence of the Center's accomplishments in this area will be monitored by the deliverables of the: (a) completion of units of nanoconcepts (b) development of simulations and online resources uploaded to the NanoEd Resource Portal and (c) incorporation of these concepts into courses and science curriculum at 7-16 grade levels.

Evaluation Foci: The evaluation efforts will focus on the following sources of quantitative and qualitative evidence of accomplishment:

- Indicators of nanconcepts integrated into units and distributed to the classroom and general public
- Tracking statistics of the usage of nanoconcepts and online discussion forums for these nanoconcepts
- Field testing the effectiveness of nanoconcepts used in the classroom
- Indication of the impact of nanoconcepts used in the classroom on STEM education

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Unit 5 Evaluation

Evaluation Criteria & Methods: Criteria for Evaluation of the Nano-concept Research will include the following:

- Usage in diverse classrooms (i.e. chemistry, biology and physics)
- Assessing knowledge gained through concept inventories
- Nanoconcepts effects on learning and teaching
- Evaluate how this impact has effected undergraduate courses and exams
- Publications and quantity of implementations by both 4 year and 2 year colleges


•Evaluation based upon this criteria will be conducted through questionnaires, concept inventories, interviews with key stakeholders and concepting mapping.

•Specifically, for the Nanomaterials Work Circle, team members plan to create the following criteria and mechanisms:

- Develop evaluation instruments for the nanomaterials-related computer animations/visualizations.
- Utilize interactive nanomaterials-related computer animations/visualizations (Superabsorbent Polymer, Photocatalytic Degradation of Methylene Blue by Titanium Dioxide, Photocatalysis Reactions of Titanium Dioxide, Manufacture of Copper Nanowires) in an undergraduate chemical engineering course with 50-100 students, to collect student feedback on how to improve them.


•The student feedback will also be incorporated into the future design of NCLT nanoconcepts.

•For all these online nanoconcepts, usage statistics and tracking are being analyzed through the team to provide quantitative documentation. Discussion forums and further inquiries into usage tracking are being planned for implementation this Fall.

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Unit 6: External Relations & Networking

- For the NCLT to accomplish its multiple goals and objectives there must be effective planning, coordination and communication within and among the Center's activity areas and projects, as well as effective utilization of the Center's human and fiscal resources. In addition, the Center has a broader and somewhat more abstract goal of achieving synergy across persons, disciplines and project areas. Such a synergistic notion is sometimes referred to as creating a context where there is a sense of "Centerness" that is shared among the members.
- **Relevant Work circles:**
 - All


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Unit 6 Evaluation

Typical Deliverables: Evidence of the Center's accomplishments towards these ends will be monitored through notes from meetings, interviews with major center participants, planning documents, and reports of activities sponsored by the Center to demonstrate how the Center programs' interdependences lead to the overall success of the Center.


Evaluation Foci: The evaluation efforts will focus on the following sources of quantitative and qualitative evidence of accomplishment:

- Indicators that cross-cutting and interdependent research activities been successfully implemented and managed,
- Indicators that Center goals are met in a timely fashion,
- Indicators that Center resources are adequately allocated, and (d) Center management promotes fruitful interactions among individuals from diverse disciplines, departments and institutions.
- Indicators that Center members and participants interact strongly and that the integrated program activities are well coordinated across partner institutions
- Indicators that important research collaborations exist among participants and members across institutions.
- Indicators that the Center effectively leverages the collective strength of its partners and that all partners participate according to their respective expertise and resources.

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Unit 6 Evaluation

Evaluation Criteria & Methods: Quantitative documentation is being supported through the management team and stored within the NCLT Cyberinfrastructure. A quantitative analysis and tracking of participation within the cyberinfrastructure, plus meeting documents will help provide evaluation of "Centerness". Documentation and analysis of contributions to presentations, posters, and Center wide deliverables will also be conducted by the management team. Surveys at Center wide meetings and interviews with key constituents within the NCLT will be conducted to ascertain a qualitative analysis of "Centerness".

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Evaluating the Evaluation Plans

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