Writing Proposals to Meet NSF's Expectations

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Caution

Most of the information presented in this workshop represents the opinions of the individual program officers and not an official NSF position.

Framework for the Workshop

Workshop Goals & Outcomes

Goal:

Prepare you to write more competitive NSF education proposals

Outcomes:

After the workshop, you should be able to:

- Identify areas where proposals can be enhanced
- Generate a list of suggestions for each area

Schedule

Workshop overview and framework
Common strengths and weaknesses
General Strategies
Goals, objectives, expected outcome
Rationale
Dissemination
Practical aspects in review process
Project evaluation
Broader impacts

Framework for the Workshop

- Learning situations involve
  - Prior knowledge
    - Some correct & some incorrect (i. e., misconceptions)
  - New Knowledge
- Learning is
  - Connecting new knowledge to prior knowledge
  - Correcting misconceptions
  - Updating long-term memory

Active & Collaborative Learning

- Effective learning activities
  - Recall prior knowledge -- actively, explicitly
  - Connect new concepts to existing ones
  - Challenge and alter misconceptions
  - Involve reflection
- Active & collaborative processes effective
- TSRL Process
  - Think individually
  - Share in small groups
  - Report to large group
  - Learn from PD's views

Workshop Format

- "Working" Workshop
  - Short presentations (mini-lectures)
  - Group exercises
- Exercise Format
  - *Think → Share → Report → Learn*
    - *(TSRL)*
- Limited Time – May feel rushed
  - Intend to identify issues & suggest ideas
    - Get you started
    - No closure -- No "answers" – No "formulas"

Participation "Rules"

- In small group discussions
  - Be brief and concise in discussions
    - Avoid lengthy comments, stories or arguments
  - Stay focused
  - Get everyone involved
  - Be positive, supportive, and cooperative
    - Limit critical or negative comments
- In reporting to large group
  - Rotate reporters
  - Report group's views not your own
  - Be brief and concise

CCLI Review Criteria and Common Proposal Strengths & Weaknesses

CCLI Program

Vision:

- Excellent STEM education for all undergraduate students.

Goal:

- Stimulate, disseminate, and institutionalize innovative developments in STEM education through the production of knowledge and the improvement of practice.

NSF Review Criteria

- All proposals are evaluated using the NSB-approved review criteria
  - *Intellectual merit*
  - *Broader impact*
- Two sets of questions to help define these criteria
  - Standard NSF set
  - CCLI-specific set

Caution About Using Suggested Questions

- Suggested questions are a *guide*
- Suggested questions are NOT
  - A complete list of "requirements"
  - Applicable to every proposal
  - An official checklist

NSF Suggested Questions for Intellectual Merit

- *Will the project*
  - Include activities important in advancing knowledge?
  - Involve qualified proposer(s)?
  - Contain creative, original, and transformative concepts?
  - Have a well conceived and organized plan?
  - Include sufficient access to resources?

NSF Suggested Questions for Broader Impacts

- *Will the project*
  - Advance discovery -- promote teaching & learning?
  - Broaden participation of underrepresented groups?
  - Enhance the infrastructure?
  - Include broad dissemination?
  - Benefit society?

CCLI Suggested Questions for Intellectual Merit

- *Will the project*
  - Produce
    - Exemplary material, processes, or models?
    - Important assessment or research findings?
  - Build on STEM education knowledge base?
  - Have expected measurable outcomes integrated into the evaluation?
  - Generate useful evaluation information?

CCLI Suggested Questions for Broader Impacts

- *Will the project*
  - Contribute to the STEM education knowledge base?
  - Lead to a broad impact on STEM education?
  - Help build the STEM education community?

CCLI Review Processes

- Program directors
  - Sort by disciplines
  - Send to group of reviewers
- Reviewers
  - Rate each proposal (E, V, G, F, and P)
  - Submit written reviews
    - Describe the strengths and weaknesses in terms of the intellectual merit and broader impacts criteria

CCLI Review Processes (Cont)

- Review panel
  - Meets and discusses proposal
  - Writes a summary of the discussion
    - Highlight strengths and weaknesses
    - Referred to as the Panel Summary

Data Collection

- Analyzed the strengths and weaknesses identified in Panel Summaries
  - CCLI Phase 1 engineering proposals from 2005 and 2006
- Developed codebook of statements describing strengths and weaknesses
  - Included complementary strength and weakness statements
    - e. g., Proposal was innovative and Proposal was not innovative
  - Identified 30 complementary statement pairs

Data Collection (cont)

- Coded the Panel Summaries for 471 proposals
- Identified the most common strengths and weaknesses cited in these panel summaries

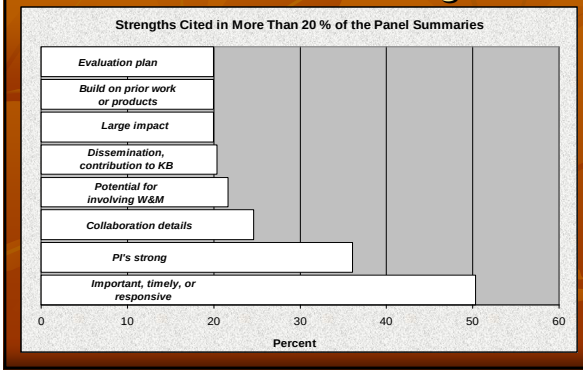
Exercise

Strengths & Weaknesses Identified by Reviewers

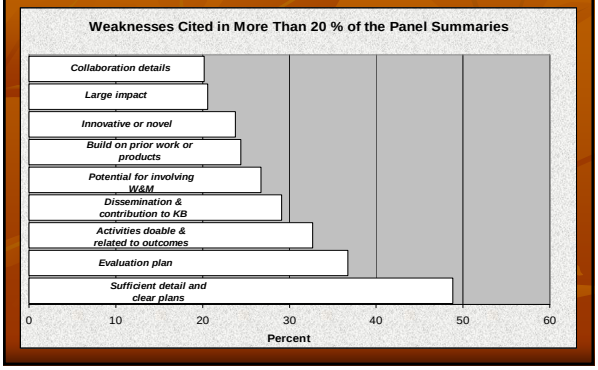
- Pretend you analyzed a stack of panel summaries to identify the most commonly cited strengths and weaknesses
- List what you think will be
  - The four most frequently cited strengths
  - The four most frequently cited weaknesses

Predict the results of our analysis

Most Common Strengths



Most Common Weaknesses



Questions

REFLECTIVE EXERCISE

- What are the two most surprising ideas you have heard so far?

Turning a Good Idea into a Competitive Proposal

Scenario: Origin of a CCLI Proposal

- *Prof ___ has taught* Signal Processing *at U of ____ for several semesters.*
- *She has an idea for* greatly improving *the course by adding "new stuff"*
  - *"New stuff"*
    - *Material (e. g., modules, web-based instruction)*
    - *Activities (e. g., laboratories, projects)*
    - *Pedagogy (e. g., problem based learning)*
- *She has done some preliminary evaluation*
- *She decides to prepare a CCLI proposal*

Scenario: Professor X's Initial Proposal Outline

- *Goals:* Develop "*new stuff*" to enhance student learning at U of Y
- *Rationale:* Observed shortcomings in educational experience of the students at U of Y and felt that *new stuff* would improve the situation
- *Project Description:* Details of "*new stuff*"
- *Evaluation:* Use U of Y's course evaluation forms to show difference
- *Dissemination:* Describe "*new stuff*" using conference papers, journal articles, and web site

Exercise
Proposal Strategy

- As a colleague, provide a few suggestions to guide Prof ____ as she develops her proposal for the CCLI program

PD's Response to Proposal Strategies

- Read the program solicitation
  - Determine how your ideas match the solicitation and how you can improve the match
- Articulate goals, objectives, & outcomes
  - Outcomes should include improved student learning
- Build on existing knowledge base
  - Review the literature
  - Present evidence that the "new stuff" is doable; will enhance learning; is the best approach
- Explore potential, meaningful collaborations

PD's Response to Proposal Strategies

- Use data to document existing shortcomings in student learning
- Describe management plan
  - Provide tasks, team responsibilities, timeline
- Provide clear examples of the approach
- Integrate the evaluation effort early
  - Build assessment tools around defined objectives and expected outcomes
  - Connect with independent evaluation experts

PD's response to Proposal Strategies

- Identify strategies for dissemination
  - Define a plan to contribute to knowledge base
  - Address broader impacts
  - Collaborate, form partnerships (build community)

Write Proposal to Answer Reviewers' Questions

What are you trying to accomplish?
What will be the outcomes? } *Goals etc.*

Why do you believe that you have a good idea?
Why is the problem important?
Why is your approach promising? } *Rationale*

How will you manage the project to ensure success?
How will you know if you succeed? } *Evaluation*

How will others find out about your work?
How will you interest them?
How will you excite them? } *Dissemination*

Goals, Objectives, and Expected Outcomes

Project Goals & Outcomes

- Goals & outcomes related to:
  - Project management
    - Initiating or completing an activity
    - Finishing a "product"
  - Student behavior
    - Modifying a learning outcome
    - Modifying an attitude or a perception
- Workshop focuses on student behavior

Developing Student Behavior Goals & Outcomes

- Start with one or more overarching statements of project intention
  - Each statement is a *GOAL*

    What is your overall ambition? What do you hope to achieve?
- Convert each goal into one or more specific expected measurable results
  - Each result is an *EXPECTED OUTCOME*

    How will achieving your "intention" reflect changes in student behavior or learning?

Goals – Objectives – Outcomes -- Questions

- Converting goals to outcomes may involve intermediate steps
  - Intermediate steps may be called *objectives*
    - More specific, more measurable than goals
    - Less specific, less measurable than outcomes
- Outcomes lead to questions
  - These form the basis of the evaluation
  - Evaluation process collects and interprets data to answer evaluation questions

Definition of Goals, Objectives, and Outcomes

Goal – Broad, overarching statement of intention or ambition
- A goal typically leads to several objectives

Objective – Specific statement of intention
- More focused and specific than goal
- A objective may lead to one or more outcomes

Outcome – Statement of expected result
- Measurable with criteria for success

NOTE: No consistent definition of these terms

Exercise

Identification of Goals/Outcomes

- Read the abstract
  - Note - Goal statements removed
- Suggest two plausible goals
  - One focused on a change in student learning
  - One focused on a change in some other aspect of student behavior

Abstract

The goal of the project is …… The project is developing computer-based instructional modules for statics and mechanics of materials. The project uses 3D rendering and animation software, in which the user manipulates virtual 3D objects in much the same manner as they would physical objects. Tools being developed enable instructors to realistically include external forces and internal reactions on 3D objects as topics are being explained during lectures. Exercises are being developed for students to be able to communicate with peers and instructors through real-time voice and text interactions. The project is being evaluated by … The project is being disseminated through … The broader impacts of the project are …

PD's Response -- Goals

- Goals may focus on
  - Cognitive behavior
    - Conceptual understanding
    - Processing skills
  - Affective behavior
  - Success rates
  - Diversity
    - Cognitive, affective, or success in targeted subgroups

PD's Response – Goals on Cognitive Behavior

***GOAL*: Improve ability**

- **Application in course**
  - Solve textbook problems
  - Describe verbally the effect of external forces on a solid object
- **Application beyond course**
  - Solve out-of-context problems
  - Visualize 3-D problems
  - Communicate technical problems orally

PD's Response – Goals on Affective Behavior

***GOAL*: Improve**

- Interest in the course
- Attitude about
  - Profession
  - Curriculum
  - Department
- Self- confidence
- Intellectual development

PD's Response – Goals on Success Rates

- **Goals: Improve**
  - Recruitment rates
  - Retention or persistence rates
  - Graduation rates

PD's Response – Goals on Diversity

***GOAL:* To increase a target group's**

- Understanding of concepts
- Achievement rate
- Attitude about profession
- Self-confidence

- ***"Broaden the participation of underrepresented groups"***

Exercise
Transforming Goals into Outcomes

Write one expected measurable outcome for each of the following goals:

1. **Increase the students' understanding of the concepts in statics**
2. **Improve the students' attitude about engineering as a career**

PD's Response -- Outcomes

Conceptual understanding

- ***Students will be better able to solve simple conceptual problems that do not require the use of formulas or calculations***
- ***Students will be better able to solve out-of-context problems.***

Attitude

- ***Students will be more likely to describe engineering as an exciting career***
- ***The percentage of students who transfer out of engineering after the statics course will decrease.***

Questions?

REFLECTIVE EXERCISE

- What are the two most surprising ideas you have heard so far

Project Rationale

Project Rationale

- Rationale is the narrative that provides the context for the project
  - It's the section that connects the "*Statement of Goals and Outcomes*" to the "*Project Plan*"
- What's the purpose of the rationale?
  - What should it contain?
  - What should it accomplish?
- What should an applicant include in the rationale?
  - What topics should a PI address?

Exercise
An Effective Rationale

Write a list of questions that the *Rationale* for a CCLI proposal should answer

(Pay particular attention to questions the reviewer will expect answered)

PD's Response
An Effective Rationale

- What does the knowledge base say about the approach?
  - What have others done that is related?
  - What has worked previously?
  - What have been the problems/challenges?
- Why is this problem important?
  - Is it a global or local problem?
  - What are the potential broader impacts?
  - How will it improve quality of learning?

PD's Response
An Effective Rationale

- What is the evidence that the approach will solve the problem?
  - Address the defined outcomes?
  - Achieve the defined outcomes?
  - Improve student learning?
- What are alternate approaches?

PD's Response
An Effective Rationale

- What are the potential problems & limitations?
  - What can be done about them?
- Has the applicant done prior work?
  - Has funded work lead to interesting results?
  - Are there any preliminary data and what do they show?

Dissemination

(Contributing to Knowledge Base & Building Community)

Reflection

- What are your thoughts about what constitutes effective dissemination of an NSF Project?

5 minutes

Russ, if you think this should be left out, that's ok by me.

Effective Dissemination Plans

- *All CCLI projects need to contribute to:*
  - *The STEM education knowledge base*
  - *Building the STEM education community*
- *All CCLI proposals need a dissemination plan*
- *How can Prof X's project "contribute to the STEM education knowledge base"?*
  - *How does she indicate this in the proposal?*
- *How can Prof X's project "help build the STEM education community"?*
  - *How does she indicate this in the proposal?*

Exercise

What is in an Effective Dissemination Plan?

Read the sample *Dissemination Plan* and list suggestions for improving it

Sample Dissemination Plan

This project will serve as a pilot for other courses at the University of ____ and at other colleges and universities throughout the country. The results of our evaluation will be disseminated on the University's web site, which will contain a special page devoted to this NSF-sponsored project. Additional dissemination will occur through presentations at conferences, such as teacher education and science education conferences, regionally and nationally, and through articles published in peer-reviewed journals.

PD's Response

Dissemination Plan (1)

- Be more proactive in promoting website & materials
- Integrate community building, dissemination, and evaluation

PD's Response

Dissemination Plan (2)

- Target and involve a specific sub-population
  - Those who teach similar course at other locations
  - Ask them to review various products, data, and approaches
  - Work with them to organize
    - Email exchanges and listserves
    - Informal meeting at a conference or on-campus
    - Faculty development workshops (on-campus and at conferences)
- Explore beta test sites

PD's Response

Dissemination Plan (3)

- Be specific about how the project will serve as a "pilot"
  - Strategy for evaluating and disseminating
  - Strategy for getting "buy-in" by others

PD's Response

Dissemination Plan (4)

- Be more specific in publication efforts
  - Indicate the specific conferences and journals
    - Include conference travel and journal page charges in budget
    - Include a tentative title & description of paper
  - Explore other venues
    - CUR (http://www.cur.org/), PKAL (http://www.pkal.org), State Academy of Science meetings
    - Professional society and specialty listserves

PD's Response

Dissemination Plan (5)

- Explore commercialization
  - Discuss contacts with software and textbook publishers
- Put material in a form suitable for the National Science Digital Library (NSDL)

Overview: Dissemination Plan

- Dissemination should be planned up-front and integrated throughout your project
  - Should not be viewed as an add-on
- Need to identify your audience(s)
- Personal interactions are important
  - Workshops, conferences, etc.
- Modular curricular design may aid dissemination
  - Users can choose all or part of your curricular products

Dissemination Plan

- Expand upon the passive "routine" plan:
  - Presenting at national conferences
  - Publishing in a national journal
  - Creating a website
- Expand upon the "routine" plan: Target specific audiences
- Explore multiple modes of communication
- May want to use "active", "proactive", "aggressive" strategies
  - "If you build it they will NOT come."
- Consider strategies that target "non-technical" audiences
  - Magazines, museums, radio shows, podcasts, youtube, etc.

Dissemination Plan

- Be comprehensive
- Provide details
- Be creative
- Consider multiple audiences
- Look at the NSDLs
- Funds in budget sufficient to achieve broad dissemination!

Questions?

REFLECTIVE EXERCISE

- What are the two most surprising ideas you have heard so far

Review Process -- Practical Aspects

Practical Aspects of Review Process

Reviewers have:

- Many proposals
  - Ten or more from several areas
- Limited time for your proposal
  - ~20 minutes for first read
- Different experiences in review process
  - Veterans to novices
- Different levels of knowledge in proposal area
  - Experts to outsiders
- Discussions of proposals' merits at panel meeting
  - Share expertise and experience

Exercise
Practical Aspects of Review Process

Write a list of suggestions (guidelines) that a colleague should follow to deal with these practical aspects

PD's Response Review Process

- Use good style (clarity, organization, etc.)
  - Be concise, but complete
  - Write simply but professionally
  - Avoid jargon and acronyms
  - Check grammar and spelling
  - Use sections, heading, short paragraphs, & bullets (Avoid dense, compact text)
- Reinforce your ideas
  - Summarize them; Highlight them (bolding, italics)
  - Do NOT overuse highlighting
- Give examples

PD's Response Review Process

- Provide appropriate level of detail
- Pay special attention to Project Summary
  - Summarize goals, rationale, methods, and evaluation and dissemination plans
  - Address intellectual merit and broader impacts
    - Explicitly and independently
    - Three paragraphs with headings:
      - "Summary"
      - "Intellectual Merit"
      - "Broader Impacts"

PD's Response Review Process

- Follow the solicitation and *GPG*
  - Adhere to page, font size, and margin limitations
    - Use allotted space but don't pad the proposal
  - Follow suggested (or implied) organization
  - Use appendices sparingly (check solicitation to see if allowed)
  - Include letters showing commitments from others
    - Avoid form letters

PD's Response Review Process

- Prepare credible budget
  - Consistent with the scope of project
  - Clearly explain and justify each item
- Address prior funding when appropriate
  - Emphasize results
- Sell your ideas but don't over promote
- Proofread the proposal
- "Tell a story" and turn a good idea into a competitive proposal

Conclusion

Read the solicitation!

Read the *GPG!*

Read the solicitation!

Read the *GPG!*

Questions?

REFLECTIVE EXERCISE

- What are the two most surprising ideas you have heard so far

Evaluation of Education Development Projects

Caution

The information in these slides represents the opinions of the individual program offices and not an official NSF position.

Workshop Goals

The session will enable you to collaborate with evaluation experts in preparing effective project evaluation plans

It will not make you an evaluation expert

Workshop Outcomes

After the session, participants should be able to:

- Discuss the importance of goals, outcomes, and questions in the evaluation process
  - Cognitive, affective, and achievement outcomes
- Describe several types of evaluation tools
  - Advantages, limitations, and appropriateness
- Discuss data interpretation issues
  - Variability, alternate explanations
- Develop an evaluation plan with an evaluator
  - Outline a first draft of an evaluation plan

Evaluation and Project Goals/Outcomes/Questions

Evaluation and Assessment

- Evaluation & assessment have many meanings
  - Individual's performance (grading)
  - Program's effectiveness (ABET accreditation)
  - Project's progress or success (monitoring and validating)
- Session addresses project evaluation
  - May involve evaluating individual and group performance – but in the context of the project
- Project evaluation
  - Formative – monitoring progress
  - Summative – characterizing final accomplishments

Evaluation and Project Goals/Outcomes

- Evaluation starts with carefully defined project goals/outcomes
- Goals/outcomes related to:
  - Project management
    - Initiating or completing an activity
    - Finishing a "product"
  - Student behavior
    - Modifying a learning outcome
    - Modifying an attitude or a perception

Goals – Objectives – Outcomes -- Review

- Converting goals to outcomes may involve intermediate steps
  - Intermediate steps frequently called *objectives*
    - More specific, more measurable than goals
    - Less specific, less measurable than outcomes
- Outcomes (goals) lead to questions
  - These form the basis of the evaluation
  - Evaluation process collects and interprets data to answer evaluation questions

Definition of Goals, Objectives, and Outcomes

Goal – Broad, overarching statement of intention or ambition
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Sample Outcomes

Conceptual understanding

- *Students will be better able to solve simple conceptual problems that do not require the use of formulas or calculations*
- *Students will be better able to solve out-of-context problems.*

Attitude

- *Students will be more likely to describe engineering as an exciting career*
- *The percentage of students who transfer out of engineering after the statics course will decrease.*

Exercise

Transforming Outcomes into Questions

Write a question for these expected measurable outcomes:

1. Students will be better able to solve simple conceptual problems that do not require the use of formulas or calculations
2. In informal discussions, students will be more likely to describe engineering as an exciting career

PD's Response -- Questions

Conceptual understanding

- Did the students' ability to solve simple conceptual problems increase ?
- Did the students' ability to solve simple conceptual problems increase because of the use of the 3D rendering and animation software?

PD's Response -- Questions

Attitude

- Did the students discussions indicate more excitement, about engineering as a career?
- Did the students discussions indicate more excitement, about engineering as a career because of the use of the 3D rendering and animation software?

Tools for Evaluating Learning Outcomes

Examples of Tools for Evaluating Learning Outcomes

- Surveys
  - Forced choice or open-ended responses
- Interviews
  - Structured (fixed questions) or in-depth (free flowing)
- Focus groups
  - Like interviews but with group interaction
- Observations
  - Actually monitor and evaluate behavior

Olds et al, *JEE* 94:13, 2005
NSF's Evaluation Handbook

Evaluation Tools

- Tool characteristics
  - Advantages and disadvantages
  - Suitability for some evaluation questions but not for others

Example – Comparing Surveys and Observations

Surveys

- Efficient
- Accuracy depends on subject's honesty
- Difficult to develop reliable and valid survey
- Low response rate threatens reliability, validity, & interpretation

Observations

- Time & labor intensive
- Inter-rater reliability must be established
- Captures behavior that subjects are unlikely to report
- Useful for observable behavior

Olds et al, *JEE* 94:13, 2005

Example – Appropriateness of Interviews

- Use interviews to answer these questions:
  - What does program look and feel like?
  - What do stakeholders know about the project?
  - What are stakeholders' and participants' expectations?
  - What features are most salient?
  - What changes do participants perceive in themselves?

The 2002 User Friendly Handbook for Project Evaluation, NSF publication REC 99-12175

Concept Inventories (CIs)

Introduction to CIs

- Measures conceptual understanding
- Series of multiple choice questions
  - Questions involve single concept
    - Formulas, calculations, or problem solving not required
  - Possible answers include "*detractors*"
    - Common errors
    - Reflect common "*misconceptions*"

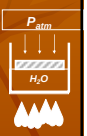
Introduction to CIs

- First CI focused on mechanics in physics
  - Force Concept Inventory (FCI)
- FCI has changed how physics is taught

The Physics Teacher 30:141, 1992
Optics and Photonics News 3:38, 1992

Sample CI Questions

H_2O is heated in a sealed, frictionless, piston- cylinder arrangement, where the piston mass and the atmospheric pressure above the piston remain constant. Select the best answers.



1. The density of the H_2O will:
   (a) Increase (b) Remain constant (c) Decrease
2. The pressure of the H_2O will:
   (a) Increase (b) Remain constant (c) Decrease
3. The energy of the H_2O will:
   (a) Increase (b) Remain constant (c) Decrease

Other Concept Inventories

- Existing concept inventories
  - Chemistry -- Fluid mechanics
  - Statistics -- Circuits
  - Strength of materials -- Signals and systems
  - Thermodynamics -- Electromagnetic waves
  - Heat transfer -- Etc.

Richardson, in *Invention and Impact*, AAAS, 2004

CAUTION….

- Developing CI is very involved
  - Identify difficult concepts
  - Identify misconceptions and detractors
  - Develop and refine questions & answers
  - Establish validity and reliability of tool
  - Deal with ambiguities and multiple interpretations inherent in language
- Typically takes several years of development

Richardson, in *Invention and Impact*, AAAS, 2004

Exercise
Evaluating a CI Tool

- Suppose you were considering an existing CI for use in your project's evaluation
- What questions would you consider in deciding if the tool is appropriate?

PD's Response -- Evaluating a CI Tool

- Nature of the tool
  - Is the tool relevant to what was taught?
  - Is the tool competency based?
  - Is the tool conceptual or procedural?
- Prior validation of the tool
  - Has the tool been tested?
  - Is there information or reliability and validity?
  - Has it been compared to other tools?
  - Is it sensitive? Does it discriminate novice and expert?
- Experience of others with the tool
  - Has the tool been used by others besides the developer? At other sites? With other populations?
  - Is there normative data?

Tools for Evaluating Affective Factors

Affective Goals

GOAL: To improve

- Perceptions about
  - Profession, department, working in teams
- Attitudes toward learning
- Motivation for learning
- Self-efficacy, self-confidence
- Intellectual development
- Ethical behavior

Exercise

Tools for Affective Outcome

Suppose your project's outcomes included:

1. Improving perceptions about the profession
2. Improving intellectual development

Answer two questions for each outcome:

- Do you believe that established, tested tools (i.e., vetted tools) exist?
- Do you believe that quantitative tools exist?

PD Response -- Tools for Affective Outcomes

- Both qualitative and quantitative tools exist for both measurements

Assessment of Attitude - Example

- Pittsburgh Freshman Engineering Survey
  - Questions about perception
    - Confidence in their skills in chemistry, communications, engineering, etc.
    - Impressions about engineering as a precise science, as a lucrative profession, etc.
  - Forced choices versus open-ended
    - Multiple-choice

Besterfield-Sacre et al , JEE 86:37, 1997

Assessment of Attitude – Example (Cont.)

- Validated using alternate approaches:
  - Item analysis
  - Verbal protocol elicitation
  - Factor analysis
- Compared students who stayed in engineering to those who left

Besterfield-Sacre et al , JEE 86:37, 1997

Tools for Characterizing Intellectual Development

- Levels of Intellectual Development
  - Students see knowledge, beliefs, and authority in different ways
    - "Knowledge is absolute" versus "Knowledge is contextual"
- Tools
  - Measure of Intellectual Development (MID)
  - Measure of Epistemological Reflection (MER)
  - Learning Environment Preferences (LEP)

Felder et al, JEE 94:57, 2005

Evaluating Skills, Attitudes, and Characteristics

- Tools exist for evaluating
  - Communication capabilities
  - Ability to engage in design activities
  - Perception of engineering
  - Beliefs about abilities
  - Intellectual development
  - Learning Styles
- Both qualitative and quantitative tools exist

Turns et al, *JEE* 94:27, 2005

Interpreting Evaluation Data

Exercise

Interpreting Evaluation Data

Consider the percentages for Concepts # 1 to 3 and select the best answer for the following statements for each question:

1. *The concept tested by the question was:*
   (a) easy (b) difficult (c) can't tell
2. *Understanding of the concept tested by the question:*
   (a) decreased (b) increased (c) can't tell

Interpreting Evaluation Data

Quest	No. of Students		Percent with Correct Answer	
	Pre	Post	Pre	Post-
1	34	32	29%	23%
2	34	32	34%	65%
3	34	31	74%	85%
-	-	-	-	-

PD's Response -- Interpreting Data

- CI does not measure difficulty
- Probably no change in understanding of Concept # 1 and # 3
- Probably an increase in understanding of Concept # 2
  - Large variability makes detecting changes difficult
  - *25 % is expected value from random guessing*
  - *There are statistical tests for identifying significant changes*

Exercise

Alternate Explanation For Change

- Data suggests that the understanding of Concept # 2 increased
- One interpretation is that the intervention caused the change
- List some alternative explanations
  - Confounding factors
  - Other factors that could explain the change

PD's Response -- Alternate Explanation For Change

- Students learned concept out of class (e. g., in another course or in study groups with students not in the course)
- Students answered with what the instructor wanted rather than what they believed or "knew"
- An external event (big test in previous period or a "bad-hair day") distorted pretest data
- Instrument was unreliable
- Other changes in course and not the intervention caused improvement
- Students not representative group

Exercise

Alternate Explanation for Lack of Change

- Data suggests that the understanding of Concept #1 did not increase
- One interpretation is that the intervention did cause a change but it was masked by other factors
- List some confounding factors that could have masked a real change

PD's Response -- Alternate Explanations for Lack of Effect

- An external event (big test in previous period or a "bad-hair day") distorted post-test data
- The instrument was unreliable
- Implementation of the intervention was poor
- Population too small
- One or both student groups not representative
- Formats were different on pre and post tests

Evaluation Plan

Exercise

Evaluation Plan

- Suppose that a project's goals are to improve:
  1. The students' understanding of the concepts in statics
  2. The students' attitude about engineering as a career
- List the topics that you would address in the evaluation plan

Evaluation Plan -- PD's Responses

- Name & qualifications of the evaluation expert
- Goals and outcomes and evaluation questions
- Tools & protocols for evaluating each outcome
- Analysis & interpretation procedures
- Confounding factors & approaches for minimizing their impact
- Formative evaluation techniques for monitoring and improving the project as it evolves
- Summative evaluation techniques for characterizing the accomplishments of the completed project.

Working With an Evaluator

What Your Evaluation Can Accomplish

Provide reasonably reliable, reasonably valid information about the merits and results of a particular program or project operating in particular circumstance

- *Generalizations are tenuous*
- *Evaluation*
  - *Tells what you accomplished*
    - *Without it you don't know*
  - *Gives you a story (data) to share*

Perspective on Project Evaluation

- Evaluation is complicated & involved
  - Not an end-of-project "add-on"
- Evaluation requires expertise
- Get an evaluator involved EARLY
  - In proposal writing stage
    - Can help with writing the evaluation plan
  - In conceptualizing the project

Finding an Evaluator

- Other departments
  - education, educational psychology, psychology, administration, sociology, anthropology, science or mathematics education, engineering education
- Campus teaching and learning center
- Colleagues and researchers
- Professional organizations
- Independent consultants
- NSF sessions or projects

Question: Internal or external evaluator?

Exercise

Evaluator Questions

- List two or three questions that an evaluator would have for you as you begin working together on an evaluation plan.

PD Response – Evaluator Questions

Project issues

- What are the goals and the expected measurable outcomes
- What are the purposes of the evaluation?
- What do you want to know about the project?
- What is known about similar projects?
- Who is the audience for the evaluation?
- What can we add to the knowledge base?

PD Response – Evaluator Questions (Cont.)

Operational issues

- What are the resources?
- What is the schedule?
- Who is responsible for what?
- Who has final say on evaluation details?
- Who owns the data?
- How will we work together?
- What are the benefits for each party?
- How do we end the relationship?

Preparing to Work With An Evaluator

- *Become knowledgeable*
  - Draw on your experience
  - Talk to colleagues
- *Clarify purpose of project & evaluation*
  - Project's goals and outcomes
  - Questions for evaluation
  - Usefulness of evaluation
- *Anticipate results*
  - Confounding factors

Working With Evaluator

Talk with evaluator about your idea (from the start)

- Share the vision

Become knowledgeable

- Discuss past and current efforts

Define project goals, objectives and outcomes

- Develop project logic model

Define purpose of evaluation

- Develop questions
- Focus on implementation and outcomes
- Stress usefulness

Culturally Responsive Evaluations

- Cultural differences can affect evaluations
- Evaluations should be done with awareness of cultural context of project
- Evaluations should be responsive to
  - Racial/ethnic diversity
  - Gender
  - Disabilities
  - Language

Working With Evaluator (Cont)

Anticipate results

- List expected outcomes
- Plan for negative findings
- Consider possible unanticipated positive outcomes
- Consider possible unintended negative consequences

Interacting with evaluator

- Identify benefits to evaluator (e.g. career goals)
- Develop a team-orientation
- Assess the relationship

Example of Evaluator's Tool – Project Logic Table

The Project
- Goals
- Objectives
- Activities
- Outputs & outcomes
- Measures & methods

Goals	Objectives	Activities	Outputs/ Outcomes	Measures

What do I want to know about my project?

(a)

(b)

Human Subjects and the IRB

- Projects that collect data from or about students or faculty members involve human subjects
- Institution must submit one of these
  - Results from IRB review on proposal's coversheet
  - Formal statement from IRB representative declaring the research is exempt
    - PI can't do this
  - IRB approval form
- See "Human Subjects" section in GPG

NSF Grant Proposal Guide (GPG)

Other Sources

- *NSF's User Friendly Handbook for Project Evaluation*
  - http://www.nsf.gov/pubs/2002/nsf02057/start.htm
- Online Evaluation Resource Library (OERL)
  - http://oerl.sri.com/
- Field-Tested Learning Assessment Guide (FLAG)
  - http://www.wcer.wisc.edu/archive/cl1/flag/default.asp
- Science education literature

Questions?

REFLECTIVE EXERCISE

- What are the two most surprising ideas you have heard so far

NSF's Broader Impacts Criterion

Exercise

Broader Impacts Categories

TASK:

- Identify the categories of activities responding to NSF broader impacts criterion
- What are some general areas where a project could have "broader Impacts"
  - e, g., Increase participation of underrepresented groups

NSF Suggested Questions for Broader Impacts

- *Will the project*
  - Advance discovery -- promote teaching & learning?
  - Broaden participation of underrepresented groups?
  - Enhance the infrastructure?
  - Include broad dissemination?
  - Benefit society?

Contained in every solicitation

Exercise

Dissemination Activities

TASK:

Identify activities that "broadly disseminate results to enhance scientific and technological understanding"

Dissemination takes two forms

- Dissemination to the broad community
  - Applies to research and education projects
- Dissemination to other users in education community
  - Specific to education projects

Dissemination -- NSF's Representative Activities I

- Partner with *museums, nature centers, science centers*, and similar institutions to develop exhibits in science, math, and engineering.
- *Involve the public or industry*, where possible, in research and education activities.
- Give science and engineering *presentations to the broader community* (e.g., at museums and libraries, on radio shows, and in other such venues).
- Make *data available* in a timely manner by means of databases, digital libraries, or other venues such as CD-ROMs

Dissemination -- NSF's Representative Activities II

- *Publish in diverse media* (e.g., non-technical literature, and websites, CD-ROMs, press kits) to reach broad audiences.
- Present research and education results in formats useful to *policy-makers, members of Congress, industry*, and broad audiences.
- Participate in *multi- and interdisciplinary conferences*, workshops, and research activities.
- Integrate research with education activities in order to *communicate in a broader context.*

Reviewing and Enhancing a Project's Broader Impacts

Exercise

Review Proposal's Broader Impacts

TASK:

- Write broader impacts section of a review
  - Outline format

Sample Proposal

- Adapted for a real proposal
  - Project Summary
  - Excerpts from Project Description
- Assume
  - CCLI Phase 1
  - $150k for 2 years
  - Intellectual merit considered meritorious

PD's Views – Review Comments I

- Scope of activities
  - Overall-very inclusive and good
  - Well done but "standard things"
  - Did not address the issue of quality
  - No clear-cut plan
  - Activities not justified by research base
- Dissemination
  - Limited to standard channels
  - Perfunctory

PD's Views – Review Comments II

- Industrial advisory committee a strength
- Collaboration with other higher ed institutions
  - Institutions appear to be quite diverse but use of diversity not explicit
  - Interactions not clearly explained
  - Sends mixed message – raises questions about partnership effectiveness
- High school outreach
  - Real commitment not evident
  - Passive -- not proactive
  - High school counselors and teachers not involved

PD's Views – Review Comments III

- Modules are versatile
- Broader (societal) benefits
  - Need for materials not well described
  - Value of the product not explained
  - Not clear who will benefit and how much
- Assessment of broader impacts not addressed

Exercise

Enhancing Broader Impacts Effort

TASK:

Identify additional or enhanced broader impacts activities that will strengthen the project

PD's Suggestions -- Enhancing Broader Impacts Effort I

- Make activities appropriate to project
  - Establish a mentoring program for high school students
  - Use undergraduate students to interact with high school students
  - Connect to other projects if appropriate

PD's Suggestions -- Enhancing Broader Impacts Effort II

- Utilize entire PI team in development process
- Take better advantage of institutional diversity (e.g., assessment of impacts of materials on diversity
- Improve Dissemination
  - Add faculty workshops
  - Prepare exhibit for local museum

Exercise

Characteristics of Broader Impacts Plans

TASK:

- Identify desirable features of a broader impacts plan or strategy
  - General aspects or characteristics

PD's Suggestions -- Characteristics of Broader Impacts Plan I

- Don't just list activities
  - Describe the *impact* of activities
  - More is not better
- Include strategy to achieve impact
  - Have a well-defined set of outcome and objectives
  - Discuss rational for expectation
  - Provide details on implementation
  - Include *evaluation and* metrics
  - Approach with same *detail* as intellectual content

PD's Suggestions -- Characteristics of Broader Impacts Plan II

- Make broader impacts *credible*
  - Realistic and believable
    - Include appropriate funds in budget
  - *Consistent* with
    - Project's scope and other objectives
    - Institution's mission and culture
    - PI's interest and experience
  - *Integrated and aligned* with other project activities

REFERENCES

Grant Proposal Guide
http://www.nsf.gov/pubs/gpg/nsf04_23/

Broader Impacts Activities
http://www.nsf.gov/pubs/gpg/broaderimpacts.pdf

Questions?

REFLECTIVE EXERCISE

- What are the two most surprising ideas you have heard so far

Thanks for your active participation!

Questions?