Developing a Competitive Proposal

Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES)

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1

Most of the information presented in this workshop represents the presenter's opinion and not an official NSF position

2

Activity
Reflection

- What are the three most important pieces of advice for a colleague writing an engineering education-focused proposal (i. e., a TUES proposal)?
- *Write your ideas on your advice*
  - *No discussion*
- Put aside and save

3

Preliminary Comments
Active & Collaborative Learning

- Effective learning activities
  - Recall prior knowledge -- actively, explicitly
  - Connect new concepts to existing ones
  - Challenge and alter misconceptions
  - Reflect on new knowledge
- Active & collaborative processes
  - Think individually
  - Share with partner -- Be brief and listen
  - Report to local and virtual groups – Be brief
  - Learn from Program Directors' responses

4

Preliminary Comments
Workshop Goal & Expected Outcomes

GOAL: Enable participants to prepare competitive proposals

OUTCOMES: Participants should be able to describe:
- Some aspects of the TUES Solicitation
- Common proposal strengths and weaknesses
- Strategies for adding strength and minimizing weaknesses
- Strategies for dealing with the practical review aspects

5

Preliminary Comments
Workshop Topics

- Introduction
- TUES Solicitation
- Common Strengths and Weaknesses
- Developing a Proposal
- Project Goals and Expected Outcomes
- Project Rationale
- Practical Aspects of Review Process

6

Transforming Undergraduate Education in Science, Technology, Engineering and Mathematics (TUES)

NSF 10-544

TUES vs. CCLI

- Title changed to emphasize the special interest in projects that have the potential to transform undergraduate STEM education

TUES vs. CCLI

Review Criteria

- Review criteria modified to emphasize the desire for projects that
  - Propose materials, processes, or models that have the potential to
    - Enhance student learning and
    - Be adapted easily by other sites
  - Institutionalize the approach at the investigator's college or university as appropriate for the Type
  - Involve a significant effort to facilitate adaptation at other sites
  - Have the potential to contribute to a paradigm shift in undergraduate STEM education

TUES Program

- VISION: Excellent STEM education for all undergraduate students
  - Majors and non-majors
  - Introductory and advanced levels

Activity

TUES Proposal Areas

- What kinds of proposals are appropriate for the TUES Program? What could a proposal address?
- Individually identify a few examples
- Report to the group

TUES Project Components

- Creating Learning Materials and Strategies:
  - Guided by research on teaching and learning
  - Incorporate and be inspired by advances within the discipline
- Implementing New Instructional Strategies:
  - Contribute to understanding on how existing strategies
    - Can be widely adopted
    - Are transferred to diverse settings
    - Impact student learning in diverse settings
- Developing Faculty Expertise:
  - Enable faculty to acquire new knowledge and skills in order to revise their curricula and teaching practices
  - Involve a diverse group of faculty

TUES Project Components (cont)

- Assessing and Evaluating Student Achievement:
  - Develop and disseminate valid and reliable tests of STEM knowledge
  - Collect, synthesize, and interpret information about student understanding, reasoning, practical skills, interests, attitudes or other valued outcomes
- Conducting Research on Undergraduate STEM Education:
  - Explore how
    - Effective teaching strategies and curricula enhance learning and attitudes,
    - Widespread practices have diffused through the community
    - Faculty and programs implement changes in their curriculum

Activity
TUES Level of Effort

- What level of effort is appropriate for TUES proposals?

- Individually identify a few levels
- Report to the group

Type 1 Projects

- 70 to 75 awards expected
- Total budget up to $200K for 2 to 3 years
  - $250K when 4-year and 2-year schools collaborate
- Deadline
  - May 26, 2011 (A-M states)
  - May 27, 2011(N-Z states)
- Typically involve a single institution & one program component – but exceptions
- Contribute to the understanding of undergraduate STEM education
- Informative evaluation effort based on the project's specific expected outcomes
- Institutionalized at the participating colleges and universities

Type 2 Projects

- 20 to 25 awards expected
- Total budget up to $600K for 2 to 4 years
- Deadline January 14, 2011
- Typically involve multiple institutions & several program components – but exceptions
- Typically based on prior work with results explicitly described – but exceptions
- Produce evidence on the effectiveness
- Institutionalize at the participating schools

Type 3 Projects

- 3 to 5 awards expected
- Budget negotiable, but not to exceed $5 M or 5 years
- Deadline January 14, 2011
- Large scale efforts
- Typically based on prior work with results explicitly described – but exceptions
- Produce evidence of student learning in a broad population
- Describe impact of the work on the prevailing models
- Describe strategies for implementation in new contexts

Tues Central Resource Projects

- 1 to 3 awards expected
- Budget negotiable, depending on the scope and scale of the activity
  - Small focused workshop projects -- 1 to 2 years & up to $100,000
  - Large scale projects -- 3 to 5 years & $300K to $3M
- Deadline January 14, 2011 for large-scale projects
- Implement activities to sustain the STEM community
- Increase the capabilities of and communications in the STEM community
- Increase and document the impact of CCLI and TUES projects

Activity
NSF Review Criteria

- What review criteria are used in evaluating TUES proposals?
- Individually identify the criteria
- Report to the group

Activity
Intellectual Merit and Broader Impacts

- What is meant by intellectual merit?
- Individually describe intellectual merit
- Report to the group
- What is meant by broader impacts?
- Individually describe broader impacts
- Report to the group

NSF Standard Questions for Intellectual Merit

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

TUES Specific Questions for Intellectual Merit

Will the project

- Produce one or more of the following:
  - Exemplary materials, processes, or models that enhance student learning *and can be adopted by other sites*
  - Important findings related to student learning?
- Build on existing knowledge about STEM education?
- Have explicit and appropriate expected measurable outcomes integrated into an evaluation plan?
- Include an evaluation effort that is likely to produce useful information?
- *Institutionalize the approach at the investigator's college or university as appropriate for the Type*

NOTE: Oversized type indicates changes from CCLI solicitation

NSF Standard 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?

Tues Specific Questions for Broader Impacts

Will the project

- *Involve a significant effort to facilitate adaptation at other sites?*
- Contribute to the understanding of STEM education?
- Help build and diversify the STEM education community?
- Have a broad impact on STEM education in an area of recognized need or opportunity?
- *Have the potential to contribute to a paradigm shift in undergraduate STEM education?*

NOTE: Oversized type indicates changes from CCLI solicitation

Proposal Strengths and Weaknesses

TUES Review Processes

- PD sorts by disciplines and sends to group of reviewers
- Reviewers rate each proposal and submit written reviews
  - Describe the strengths and weaknesses in terms of the Intellectual Merit and Broader Impacts criteria
- Panel meets
  - Discuss the strengths and weaknesses in terms of the Intellectual Merit and Broader Impacts criteria
- Panel writes a summary of the discussion
  - Highlight strengths and weaknesses
  - Called Panel Summary

Proposal Strengths and Weakness

- Analyzed Panel Summaries for 471 CCLI proposals
- Identified the most common strengths and weaknesses

Activity
Strengths & Weaknesses

- What do you think are the most common strengths and weaknesses

  Predict the results of our analysis

- Individually identify the most common strengths and weaknesses
- Share it with a neighbor or two
- Report to the group

28

Top Ten Strengths

Topic is important and timely, introducing new material; or it is responsive to an industry or community need
PIs are experienced, strong, and technically sound
Proposed collaboration with other organizations (e.g., diverse 4-year schools, community colleges, K-12, etc.) is detailed and believable
Proposal has good potential for involving minorities or women
Dissemination plan is excellent and will contribute to STEM education knowledge base.
Proposed ideas are likely to have a large impact (e.g., Number of students, broadness of idea, etc.)
Proposed ideas build on prior work or existing products
Evaluation plan is excellent, outstanding, or good
Proposed ideas are novel or innovative
Proposed activities include non-traditional pedagogy

Top Ten Weaknesses

Proposed activities are not described in sufficient detail with clear plans
Evaluation plan is missing or incomplete
Proposed activities are judged to be not doable or they will not result in expected outcomes
Dissemination plan is inadequate and will not contribute to STEM education knowledge base
Proposal does not have good potential for involving minorities or women
Proposed ideas do not build on prior work or existing products
Proposed ideas are not novel or innovative
Proposed ideas are not likely to have a large impact (e.g., Number of students, broadness of idea, etc.)
Proposed collaboration with other organizations (e.g., diverse 4-year schools, community colleges, K-12, etc.) is not detailed or believable
Topic is not important and timely, does not introduce new material, or is not responsive to an industry or community need

Areas of Strength and Weakness

- Important, timely, responsive to need
- Large impact
- Novel or innovative
- Prior work
- Non-traditional pedagogy
- Details
- Doable
- Collaboration
- Minorities or women
- Evaluation
- Dissemination
- *Transportable*
- *Institutionalized*

Adding Strength and Avoiding Weakness

- Describe project's goals and expected outcomes
- Describe the project's relationship to prior work, theoretical basis, pedagogical approach, importance, impact, timeliness, innovativeness (i. e., the project's rationale)
  - Specific
  - Evidenced-based
  - Referenced
  - Related to goals and outcomes
- Describe project's plans for implementation, evaluation, dissemination, collaboration, impacting underrepresented groups
  - Clear
  - Detailed
  - Doable
  - Related to goals and outcomes

Developing a Proposal

(Converting a Good Idea into a Fundable Project)

33

Elements of a Competitive Proposal

- Competitive proposals contain a
  - Great idea
  - Well designed project developed around the idea
  - Convincing description of the project
- Non-competitive proposals lack one or more of these elements
- The workshop addresses approaches for converting a good idea into a well designed project and a convincing proposal

34

Organization of a Project

- Goals and expected outcomes
- Rationale
  - Introduction
  - Background (prior work, theoretical basis)
  - Justification (importance, impact, need)
- Project Plans
  - Implementation plan
  - Evaluation plan
  - Management plan
  - Dissemination plan

Note: There are other organizations

35

Project Development Model

- Think of the project as a single entity, not a group of individual (independent) elements
- Design the project in an iterative process with "successive refinement"

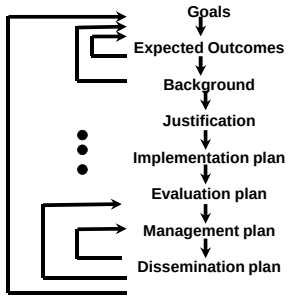
36

Linear Model

Goals
↓
Expected Outcomes
↓
Background
↓
Justification
↓
Implementation plan
↓
Evaluation plan
↓
Management plan
↓
Dissemination plan

37

Iterative Model



38

Project Goals & Expected Outcomes

39

Project Goals

- **Goals: define your ambition or intention**
  - ***What is your overall ambition?***
  - ***What do you hope to achieve?***
  - ***Goals provide overarching statements of project intention***
- ***Two types of goals***
  - ***"Project management" goals***
    - ***Start or complete some activity or product***
  - ***Student behavior goals***
    - ***Change the students' or instructors' knowledge, skills, or attitudes***
    - ***Change the students' success rates or diversity***

40

Project Expected Measurable Outcomes

- **Learning goals identify the intended change in knowledge, skills, or attitudes**
- **Expected measureable outcomes**
  - **Identify the observable changes in behavior if goal is obtained**
  - **One or more specific observable results for each goal**
    - ***How will achieving your "intention" reflect changes in student or faculty behavior?***
    - ***How will it change their learning? Their attitudes? Their successes? Their diversity?***

Activity

Developing Project Goals

Consider the following abstract and list some possible goals for this project

- ***Use student perspective not instructor or material perspective***
- ***Not "Develop material…" or "Incorporate material …"***

- **Individually identify a few goals for student learning and a few for non cognitive changes in students**
- **Share it with a neighbor or two**
- **Report to the group**

42

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

Types of Project Goals

Goals may focus on:

- Cognitive behavior
  - Conceptual understanding
  - Processing skills
- Affective behavior
- Success rates
- Diversity
  - Cognitive, affective, or success goals in underrepresented groups

44

PD's Response

Goals for Cognitive Behavior

Within the context of the course

- Improve ability to
  - Describe or utilize course concepts
  - Solve textbook problems
  - Verbally explain solution
  - Use the visualization software tool

Beyond the context of the course

- Improve ability to
  - Extend course concepts to other areas
  - Solve out-of-context problems
  - Discuss technical issues
  - Work effectively in teams
  - Visualize 3-D models
  - Critical thinking

45

PD's Response

Goals for Affective Behavior

Improve students

- Self-confidence
- Intellectual development
- Interest in or attitude about engineering

46

PD's Response

Goals for Success Rates

- Improve
  - Recruitment rates
  - Retention or persistence rates
  - Graduation rates
- NOTE: This is not appropriate as a main goal for a TUES proposal

47

PD's Response

Goals for Diversity

Increase a target group's

- Understanding of concepts
- Achievement rate
- Self-confidence

"Broaden the participation of underrepresented groups"

NOTE: This is not appropriate as a main goal for a TUES proposal

48

Expected Measureable Outcomes

- Achieving a cognitive or affective goal should change the way students behave
  - They will demonstrate changes in their behavior reflecting changes in their knowledge, skills, or attitudes
- Consider a room full of students where some had achieved the goal, some had not
  - How would you determine if a particular student achieved the learning goal?
  - What question, activities, or tasks would uncover these changes?

Activity

Transforming Goals into Expected Outcomes

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

- **Increase the students' out-of-context problem solving skills**
- **Improve the students' attitude about engineering as a career**

50

PD's Response

Expected Outcomes

Problem solving

- *Students will be better able to*
  - *Draw a model, or appropriate abstraction or representation*
  - *Identify the issues, variable, parameters, etc in a problem*
  - *Identify and consider several alternate solution paths*
  - *Use an iterative process to try, test, and refine an approach*
  - *Communicate their solution and discuss its reasonableness*

Attitude

- *Students will be better able to describe engineering as*
  - *An exciting career*
  - *A career that solves real and important problems*
- *Students will be better able to discuss the role of engineering in a current event*
- *Students will take subsequent courses at a higher rate*

51

Overview

Goals and Expected Outcomes

- **Ultimately the goals and expected outcomes should convince the reader that the applicant has**
  - **A clear understanding of what he or she is trying to achieve**
  - **A clear understanding what he or she expects to observe when this is achieved**

52

Project Rationale

53

Project Rationale

- **Rationale provides the context for the project**
- **It provides**
  - **Background**
  - **Justification**
- **Connects the "*Statement of Goals and Expected Outcomes*" to the "*Project Plan*"**

54

Activity

Developing the Project's Rationale

List the areas that should be discussed in the rationale

- Individually identify several factors that should be discussed
- Share these with a neighbor or two
- Report to the group

55

PD's Response

Developing the Rationale

- Background for the approach
  - Prior work by others
    - Referenced to the literature
  - Prior work by applicant
    - Preliminary data
  - Relevant theory
    - Referenced to the literature

56

PD's Response

Project Rationale (cont.)

- The importance of the problem
  - Incorporates new disciplinary knowledge
  - Addresses an emerging area or known problem
  - Meets an industry need
- The potential impact of the work
  - Number of students
  - Transportable to a large number of institutions
  - Serves as model for other areas
- Potential contributions to teaching & learning knowledge base

57

PD's Response

Developing the Rationale (cont.)

- Potential problems, limitations, alternate approaches
- Include rationale for broader impacts

58

Overview

Project Rationale

- Ultimately the rationale should convince the reader that the applicant
  - Has identified an important, big-impact problem
  - Understands the problem and the prior work
  - Has thought seriously about broader impacts

59

Some Tips

- Clear goals and expected measureable outcome
  - Reflect student learning of new knowledge or skills
  - Basis of the evaluation plan
- Convincing rationale
  - Discuss previous work, theory, impact (referenced)
  - Similar to the rational for a research proposal
- Coherent presentation
  - Goals, outcomes, relational, planned activities, and evaluation connected
- Inquiry-based approaches vs. traditional lecture
  - *How People Learn*
- General not local issue, opportunity, or problem
  - External vs internal focus
  - Model or product vs. course or implementation
- Transportability and dissemination considered from beginning

Activity

Inquiry-based approaches

- What does it mean to have an inquiry-based approach?
- Why is this important?

- Individually identify a few approaches
- Report to the group

Inquiry-Based Approaches

- Instruction is learner-centered not teacher-centered
  - Focus is on what students learn and not on what is taught
- More effective
- Learning must be "constructed" – it cannot be "absorbed"
  - Must be connected to existing knowledge

Activity

General vs Local Issue, Opportunity, or Problem

- How would you convince the reader that your proposal dealt with a general issue, opportunity, or problem
  - That it had an external vs internal focus

- Individually identify a few approaches
- Report to the group

General vs Local Issue, Opportunity, or Problem

- Focus on developing a set of instructional material not on implementing a course or lab
  - Focus on developing a product and not a specific implementation
- Discuss how it would work in different settings
  - With other curriculum models
  - With students with different background
- Engage faculty members for other schools in some capacity
- Include active, targeted dissemination
- Provide evidence that it is a global issues, opportunity, or problem

Transportable Approach

- How would you convince the reader that your approach was transportable?
- That you would facilitate its use by others?
- That you are serious about dissemination?

- Individually identify a few approaches
- Report to the group

Transportable Approach

- Similar to previous list

Review Process -- Practical Aspects

Practical Aspects of Review Process

Reviewers have:

- Many proposals to read
  - 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

Activity

Practical Aspects of Review Process

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

- Individually identify several guidelines
- Share these with a neighbor or two
- Report to the group

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, headings, short paragraphs & bullets (Avoid dense, compact text)
- Reinforce your ideas
  - Summarize; Highlight (bolding, italics)
- Give examples

PD's Response

Review Process

- Provide appropriate level of detail
- Pay special attention to Project Summary
  - Summarize goals, rationale, methods, 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 NSF Grant Proposal Guide (*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
    - "Support letters" are not allowed
    - 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

73

TUES Program – Information Sites

- **Solicitation**
  http://www.nsf.gov/pubs/2010/nsf10544/nsf10544.htm
- **Search awards**
  http://www.nsf.gov/awardsearch/tab.do?dispatch=2
  - **Use "Search All Fields" tab**
    - **Enter key words**
    - **Enter "Element Code" -- use "Lookup" link on right**
    - **Select "Any" vs "All"**
- **Can request copy of proposal from PI or NSF through FOIA**
  http://www.nsf.gov/policies/foia.jsp
  - **Use carefully – Not a "template" for your idea**

74

Activity

Reflection

- **What is the most important advice that you would give to a colleague writing an engineering education-focused proposal (i. e., a TUES proposal)?**
- ***Write your ideas on your advice***
  - ***No discussion***

75

Activity

Final Reflection

Review your reflective statements

- **How have they changed?**
- **What have you learned?**

- **Individually review your statements**
- **Share these with a neighbor or two**
- **Report to the group**

76

Questions